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SOILS OF THE NETHERLANDS. 2. SOIL SURVEY AND LAND RECLAMATION BY J. K. Coulter, B.Sc., B. AGR., DIP. AGR. SCI. (CAMB.), A.R.I.C.

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THE USE OF SELF-PROPELLED COMBINE HARVESTERS FOR THE HARVESTING OF WET PADI IN THE NORTH KEDAH PLAIN BY D. W. M. Haynes.

DEPARTMENT OF AGRICULTURE, FEDERATION OF MALAYA.

Kuala Lumpur.

PRICE $2

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(Continued.)

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EDITORIAL

Soils of the Netherlands. The concluding portion of Mr. J. K. Coulter's paper on soil survey and land reclamation shows the thoroughness with which this immense project has been carried out by the Dutch. In reclaiming the North-east Polder from the Zuider Zee a dyke 21 miles long had to be built in order to keep out the waters of the North Sea. The preliminary work involved compiling a soil map which, with the subsequent construction of open, tile and boundary drains, is fully explained. Mr. Coulter's paper also deals with recent work on deficiency in soils of copper, magnesium, molybdenum and manganese.

Costings of Mechanical Operations. The various elements which are involved in calculating costs of mechanical operations are clearly explained in a well-tabulated article by the Agricultural Engineer, Mr. D. W. M. Haynes. Although the main costs are labour plus fuel (comprising variable or running costs) and maintenance plus depreciation (comprising constant or fixed costs), yet there are in addition many secondary elements such as supervision, interest on capital and insurance.

In the figures showing analysis of costs it is interesting to compare the relative amounts spent on a combine in Malaya compared with the United Kingdom. Whereas maintenance in the former reaches 40 per cent. as against 15 per cent. in the latter, fuel costs in Malaya are just over 12 per cent. compared with 31.6 per cent. in Britain.

Padi Harvesting with a Self-Propelled Combine. A second article by Mr. Haynes deals with the testing under field conditions of the Massey-Harris No. 80 Self-Propelled Rice Special Combine. Details of the field tests in the North Kedah Plain are described with the influence of weather, soil and crop conditions, not forgetting mechanical failures and recommended settings. This paper gives full details on working rates, output, estimates of the combine's useful life and the acreage combined.

Current Departmental Work. The work of the Department is shown in the reports on current investigations and extension work by the Research, Agronomy and Field Divisions to which is added the half-yearly Mechanisation Progress Report.

SOILS OF THE NETHERLANDS

(Concluded)

A Report on a Visit to the Netherlands to Study some of the Work being done on Peat, Sulphurous Soils, and Soil Survey.

2. SOIL SURVEY AND LAND RECLAMATION

BY

J. K. COULTER,

Acting Senior Chemist (Soils).

Soil Survey.

The Soil Survey Organisation of the Netherlands is bigger than that in Great Britain although it has to cover a much smaller area. Attached to the Soil Survey Institute at Bennekom is a cartography section which is engaged in making maps of the areas surveyed. Mapping is generally carried out on scale of 1 : 10,000; for publication, on a scale of 1 : 25,000. Colour photographs of the profiles are kept in the records.

A great part of the soil survey of the Netherlands is concerned with alluvial deposits, either in the form of soils which are now in use or of those being investigated for future reclamation. Consequently, a great deal of work has been done on alluvial soils, not only on their physical and chemical properties but also, by making deep borings over cross-sections of the area, investigating the manner in which they have been deposited. It is necessary to have a knowledge of the manner of deposition of the soils in order to map them properly. In some areas the following sequence may be noted from the surface to a depth of, say, 12 ft.—young marine clay, peat of the sub-boreal period, old sea clay, peat of the boreal-Atlantic period and Pleistocene sand. This adds to the difficulty of mapping as do the levees and raised beds of former creeks and streams in the peat area. In some of the inland areas the influence of the large rivers can be traced in the formation of the soil, coarser sand is found near the river whereas fine clay, known as basin clay, is further away. Again, in certain places the presence of former dyke bursts can be inferred from their influence on the soil and the spread of coarse sand and gravel over considerable areas.

An interesting example of the use of soil survey in the Netherlands is the reclamation of the Zuider Zee. In the North-east Polder a complete soil map of the area was prepared while it was still under water—in some places to a depth of 15 ft. The samples were taken from a boat by means of a special type of sampler. This sampler was in the form of a long, tapering box attached to a long handle and had one side which was removable so that the profile layers could be examined as they

occurred in the soil. Sampling was to a depth of 1½ m. below the top of the soil, and a sample was taken from about every 100 acres. Plant nutrients, calcium carbonate, sulphides and mechanical analysis were determined on the samples and shrinkage measurements were made. Thus, before drainage was started a complete soil map was available and this was used to plan the future agriculture of the area. It was possible to decide from the map where to place the farms and which areas should be taken up for market gardening and forestry. Furthermore, since the main canals were dug while the area was under water, it was possible to take the spoil from the canals and use it to provide soil cover for some of the areas which had poor soil.

Land Reclamation and Drainage.

Apart from the large reclamation works, many small schemes of reclamation are being carried out, and for these a certain amount of seasonably employed labour is used. It has been stated that economic conditions in the Netherlands do not always warrant much mechanisation of soil improvement and careful discrimination between the layers in the soil profile demands more accuracy than is possible with machinery. For these reasons the use of unemployed labour to carry out land improvement schemes is a practical proposition (8).

In the south-west the writer saw reclamation being carried out on the bottoms of some old lakes; these were areas which had formerly been covered with peat and had been cut over for fuel. The resultant lakes had been dyked and drained but the surface was very uneven. The peat was being cut off by hand and used to fill in the hollows. Beneath the peat was a layer of 'cat' clay and great care was being taken to leave it buried as deep as possible.

Another interesting area where reclamation was seen was the sand dune areas. Here the sand dunes were being levelled and the surplus sand sold for making roads in other parts of the country. The resultant area is very level and the water table is rigidly controlled at a depth of 50 to 55 cm. below the surface. The resultant soil contains little organic matter but is calcareous. It has to be planted with small beech hedges to prevent blowing but it is some of the most valuable agricultural land in the world.

In another area the writer saw reclamation being carried out on the heath peat of the north-east. Here the peat was being dug over to a depth of 3 ft. or so and the sand which lay underneath was used to cover the surface of the peat to a depth of 8 to 10 in. This work was also being done by hand and illustrates the expense and trouble to which the people go when reclaiming land.

The show piece of reclamation is of course the Zuider Zee, and the preliminary work in the North-east Polder was mentioned earlier under Soil Survey. For reclamation, a large dyke, 21 miles long, was built from North Holland to the Friesland coast; this keeps out the North Sea and turned the former Zuider Zee into a lake, the Ijsselmeer. Before

the area was reclaimed, a trial polder of 100 acres was made and various research projects relating to drainage, cultivation and manuring were carried out. Four polders were planned and two of these—the Wieringermeer in the north-west with an area of 50,000 acres and the North-east Polder with an area of 110,000 acres—have been completed. After the enclosure of the polders the tremendous task of pumping out the water starts. This may take 6 months or more, even though some of the pumping plants have a capacity of as much as 129,000 cu. ft. of water per minute.

Drainage.

When the surface has been drained the area still remains water-logged and has to be further drained by small, open drains. These are made either by hand or by special drainage ploughs. The drains are about 21 in. deep and between 8 and 12 yd. apart. In heavy clays it may be necessary to have the drains only 7 yd. apart. Under this type of drainage the salt will wash out of the coarse soils in one year and out of the clayey soils in two to three years. It is necessary to have open drains close together until the soil dries out sufficiently to crack, then drainage becomes much easier. Open drains are then replaced by tile drains 30 to 36 in. deep and up to 30 yd. apart. It is necessary to have the drains closer together in the fine sands as they do not crack and are not as permeable as the cracked clays. After the tile drains have been laid, a thin layer of filtering material, often coarse peat dust, is placed on and around the tiles. A layer of top soil is deposited on top of this, followed by the rest of the original soil. If the pH is low, lime is often applied to the soil in the ridge to increase the permeability (3). The general drainage of the farm is by means of the boundary drains which are 330 yd. apart and about 5½ ft. deep. Owing to the nature of the soil it is necessary to dig these drains with very sloping sides. The boundary ditches discharge into the secondary canals, which are parallel and about one mile apart, which in turn discharge into the main canals.

Settlement.

In the older polders, e.g. the Haarlemmermeer, the land, after being drained, was handed over to the prospective farmers. This has now been changed because under the old scheme the first cultivators had to contend with enormous difficulties such as shortage of labour, primitive dwellings and, in the first years, frequent failures owing to excess of salt. A well known saying with reference to the settlers is "The first works himself to death, the second is always in difficulties and the third earns a living".

In the North-east Polder, the Government decided that the State should carry out not only the dykeing and drainage of the area but should also cultivate it for a number of years until the soil was in good condition. Huge State farms were established and for these a large pool of mechanised equipment was set up with large workshop facilities. The reclaimed area represented a planner's paradise since there were 110,000 acres with

literally nothing on them. As soon as one area has been brought into cultivation it is handed over to the tenants; buildings and dwellings have already been provided on each lot. The usual size of farm is one section (60 acres); a few have two sections and some half a section. There is very keen competition for tenancy of these farms and applicants are very carefully selected. A number of farms are reserved for the labourers who have worked on the reclamation scheme. When the North-east Polder is finally developed it will have 4,000 farms with 50,000 people on 110,000 acres. The main village, Emmeloord, will have 12,000 inhabitants and there will be ten subsidiary villages.

Soil Research in the Netherlands.

In the Department of Agricultural Chemistry at Wageningen, the writer saw work being carried out on the measurement of degree of irreversible drying out of peat soils. Special methods for determining this have been evolved in this laboratory. Work was also being carried out on the moisture content of soils and determination of the wilting point. A polarograph was being used for estimation of zinc, and experiments were being carried out on its use for the estimation of copper and cobalt.

The Agricultural Experiment Station and Institute for Soil Research T.N.O., Groningen were also visited. The Institute is engaged in carrying out both research and advisory work, in the advisory section upwards of half a million analyses being made each year. A large number of investigations into various trace element deficiencies is also being carried out.

During discussion on deficiency of copper it was stated that deficiency symptoms could be brought about by either actual shortage of copper in the soil or by fixation of the copper. Some types of soils appeared to fix copper readily, while in other soils it could be rendered ineffective through action of sulphate-reducing bacteria, e.g. H_2S-forming bacteria such as *Vitrio desulphuricans*. For extracting copper from the soil it was suggested that citric acid buffered with NaOH to a pH of 6.2 could be used.

Magnesium deficiency in fruit trees, cereals and grass was discussed and the writer was shown a number of graphs which demonstrated the antagonism between the magnesium ion and the ammonium ion. In magnesium-deficient sandy soils, ammonium sulphate depressed growth even though magnesium was added. If sodium nitrate was used instead, no such difficulty was encountered. This magnesium ion—ammonium ion antagonism is interesting as a similar finding has been reported for oil palms in Malaya.

Next to be discussed was deficiency of molybdenum. The first field symptoms of this were discovered in the iron-stone soils of Western Australia. Later, a similar deficiency was discovered in the Netherlands on certain of the soils which had a high content of bog iron ore. The discovery in Australia was associated with the failure of clovers on some

of the soils. The dependency of clover on a supply of molybdenum was shown very clearly by growing clovers in soil in glass dishes covered with black paper. When the paper is removed the roots of the clover covered with nodules can be seen. Where the molybdenum is absent there are many nodules developed on the roots but they are small and appear to be ineffective in the fixing of nitrogen. Where there is sufficient molybdenum the nodules are fewer but much larger. It would appear that molybdenum deficiency is most liable to occur in soils which have a large capacity for phosphate fixation. This may apply to some of the laterite soils in Malaya.

Manganese deficiency is also known in the Netherlands, the symptoms being often brought about by over-liming, the deficiency appearing as soon as the pH is raised near neutrality. Where deficiency symptoms occur they can be cured by the use of sprays.

At Groningen, a considerable amount of work has been carried out into measurements and examination of root development of both cereals and tree crops. For measurement and examination of roots ofcereals a 'needle board' is used. This consists of a board about 3½ ft. long and 10 in. wide in which is placed a series of nails about 3 in. long and 3 in. apart. A profile is dug and this board is pushed into the side of the pit. The soil at the sides is then cut away and the board with a 3 in. layer of soil on it removed. The soil is then washed away by a gentle stream of water and the roots are left held in their original position by the nails. Measurements can then be taken and photographic records made. For tree crops this method cannot, of course, be used, and in this case a root-counting method is employed.

A very neat method for taking and storing monoliths of soil profiles was also shown to the writer. The monoliths are taken from the side a pit by sticking them on a board with cellulose acetate. They are then removed to the laboratory and cut down to a thickness of about 2 in., the 'natural' look of the profile being obtained by using a strong blast of air. They are then sprayed with a solution of colourless vinylite resin which prevents them drying and preserves the natural colour of the soil.

While at the T.N.O. the writer also visited the laboratory of Dr. Gerretsen who has carried out work on the determination of trace elements using micro-biological methods, particularly the use of *Aspergillus niger*. These methods can be used for the determination of zinc, copper and molybdenum and also magnesium. The method appears simple enough and does not require any expensive apparatus. It is superior to chemical methods in that it determines more readily the amount available to the plant. On the other hand, only certain strains of *Aspergillus* are suitable and difficulty is sometimes encountered in getting reproducible results.

Acknowledgements.

The writer's best thanks are due to Prof. Edelman, Director of the Soil Survey Institute, and his staff for the trouble they took in

arranging the field trips and for the detailed instructions which they gave as regards travelling, hotel accommodation etc. The writer is also very grateful to the staff of the Agricultural University, Wageningen, and the Director and staff of the T.N.O., Groningen, for the time and trouble they took in explaining much of the work which was being carried out.

Thanks are also due to Dr. E. W. Russell, Reader in Soil Science, University of Oxford, for suggesting this trip and making the initial arrangements.

Finally, the writer wishes to acknowledge the good offices of the Malayan Government and the Director of Agriculture in giving permission for the visit.

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THE CALCULATION OF COSTS OF MECHANICAL OPERATIONS WITH PARTICULAR REFERENCE TO THE MECHANIZED HARVESTING OF RICE

BY

D. W. M. HAYNES,

Agricultural Engineer.

Introduction.

During the past six years, tractors and implements have been introduced into the Federation of Malaya in relatively large numbers. The increase has been particularly marked in the case of small wheeled tractors and their associated implements, the numbers of which have risen from 87 units in December, 1949, (2) to approximately 950 units at the end of 1953. The technique of using these machines for dry land work has been fairly well established and, although in some operations there is still vast scope for the introduction of new machines and methods, interest is now largely focussed on the economic aspects of mechanization. Even in the case of wet padi cultivation many of the necessary operations can now be performed regularly on certain types of soil and enough experience has been gained with various types of machinery to indicate that, under certain conditions, the complete mechanization of the wet padi crop is possible and the economics of mechanization are now receiving more attention than in the early days of mechanical investigations.

The cost of a mechanical operation may be found by observations or routine records or may be estimated from other data but the purpose of calculating the cost is always, basically, to make a comparison. The comparison may, in some cases, be between a machine and hand labour doing the same job or it may, in others, be between the cost of producing a crop and its value on the market, but even where a costing figure is quoted by itself, a comparison with other costs is implied.

It is important, therefore, that where costing figures are to be quoted in published reports all the figures should be calculated on the same basis or, if a standard costing procedure is not applicable to the particular operation, the method adopted and the reasons for its adoption should be described.

The cost of any mechanical operation is made up of a number of elements or items each of which must be expressed in dollars and cents. Some of these elements, such as fuel costs, are simple and their evaluation merely involves observation and calculation. Others such as depreciation, can be calculated from known figures in many different ways, each of which has its particular virtue and each of which gives a different result. In the simplest case the elements which make up the cost of an operation are:—

I	Labour costs.	A. Running costs, p.57.
II	Fuel costs.	
III	Maintenance and repair of the equipment.	B. Fixed costs, p.61.
IV	Depreciation of the equipment.	

Costings made up from these four elements are easily obtained or estimated and for many purposes they are quite sufficient. The final answer in dollars and cents, however, does not truly show the cost of the operation. Many secondary elements such as cost of supervision, provision of housing, welfare and medical services for the men employed, interest on the capital invested in spare parts stocked and depreciation of tractor sheds and workshops, should also be included if the true cost of the operation is to be shown.

These secondary elements will vary from case to case but may include some or all of the following:—

V Interest on capital or on loan with which equipment was purchased.

VI Supervision and clerical work.

VII Cost of moving equipment to job.

VIII Cost of transporting labour and fuel to job.

IX Depreciation on tractor sheds, workshops, fuel stores and other fixed installations.

X Interest on capital invested in stocks of essential spares.

XI Proportion of cost of storekeepers and mechanics in so far as these are not included in maintenance costs.

XII Proportion of cost of provision of welfare, educational and medical services for the labour employed.

XIII Road taxes.

XIV Insurance of equipment.

XV Proportion of insurance of stores, tractor sheds, workshops, fuel stores and other fixed installations.

Where any or all of the secondary elements listed above are included in calculating the cost of a mechanical operation, care must be taken to see that similar and, perhaps, additional elements are included in the cost of performing the same operation by hand or other methods if comparisons are to be made. It must also be borne in mind that mechanization may increase the yield per acre or the total yield per holding or, in the broadest view, the yield per country, by making possible operations which could not be done in the proper season with the labour available and, if a value cannot be set upon this increase, due allowance must be made when making comparisons. It may also be necessary, where a very accurate picture of the economics of an operation or enterprise is needed, to include on additional element containing a proportion of the labour charges and other annually recurrent expenditure incurred when no productive work is in progress due to bad weather or to the land being occupied by a growing crop.

It will be seen that, in the list of elements given above, only labour and fuel costs will vary greatly between different operations: the other major elements, depreciation and maintenance, are based upon the initial cost of the equipment and the maintenance schedule laid down in the manufacturer's instruction book and the secondary elements will vary according to cost of the equipment and other factors quite unconnected with the operation itself. It is possible, therefore, to divide the total cost into running costs and fixed costs, the former including labour and fuel elements, which vary between operations, and the latter including all the other elements which are constant for any particular organization or enterprise. (It should be noted that the cost of repairing accidental damage and fair wear and tear of the equipment will vary according to the particular operation undertaken and according to conditions at the site and should properly be included as a variable in the running costs rather than a fixed cost. There are, however, so many unknown factors influencing breakages that it is impossible to calculate a figure for each operation and it is convenient to use an average figure which is constant and thus may be included in the fixed costs.)

The relative proportions of fixed and running costs for four harvesting operations are shown diagrammatically in Figure 1. It will be seen that, under Malayan conditions, fixed costs account for more than half of the total cost in every case. Even in the case of combining in the United Kingdom (where the cost of labour and fuel is higher and maintenance calculated on a different basis) depreciation and maintenance account for 48.4 per cent of the total cost. It is important, therefore, that the elements in the fixed costs should be calculated as accurately as possible on a sound basis and that the method adopted should be explained in detail so that, when necessary, due allowance may be made when comparing costs quoted at different times and different places.

Costing Methods adopted by the Department of Agriculture.

In order to facilitate comparisons and to obviate reptition in published costings, the Department of Agriculture adopted in 1947 (1) a standard method of calculating costs. It was considered unnecessary and impractical to take into consideration supervision and other secondary elements and only the four major elements, labour, fuel, maintenance and depreciation were included in the costings. With minor modifications (3) this standard method has been used for all costs quoted and has proved very satisfactory but it is now considered that revision is justified by experience which has been gained over the past six years and by minor changes in the pay structure for tractor operators and labourers.

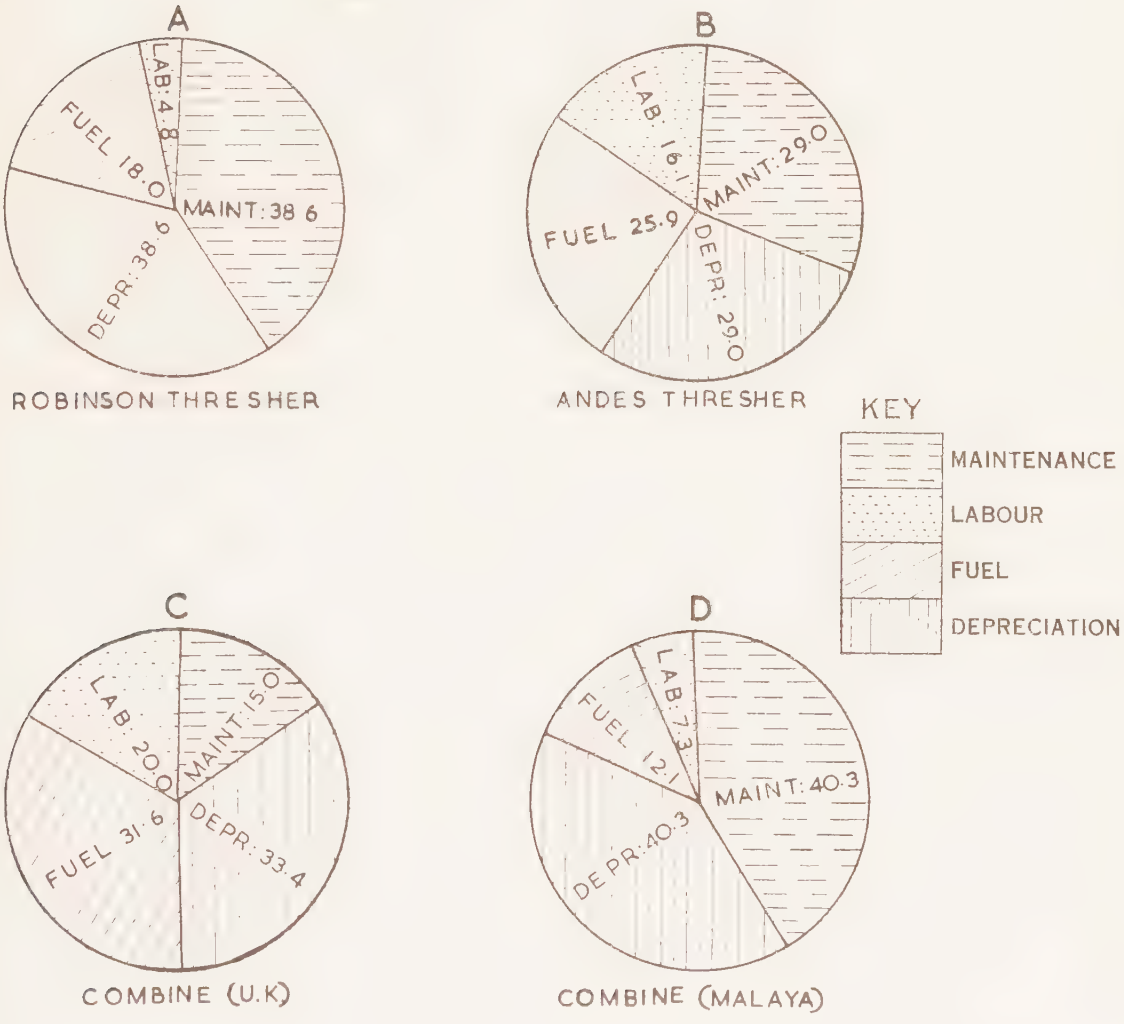
A. RUNNING COSTS.

The variable elements included in running costs are capable of direct measurement and can be quoted exactly where costs are being calculated for an operation which has actually been performed. It has

FIGURE 1.

ANALYSIS OF COSTS

SHOWING THE RELATIVE IMPORTANCE OF THE FOUR MAJOR ELEMENTS



EXAMPLES A, B & D HAVE BEEN CALCULATED BY THE METHOD DESCRIBED IN REFERENCE (1)

EXAMPLE C IS BASED ON FIGURES GIVEN BY C. CULPIN IN "FARM MACHINERY"

been shown that fixed costs, which are estimates, account for over half of the total cost of an operation, and it will therefore be seen that, for most purposes, there is little need to record the man-hours and fuel used with great accuracy. Servis Recorders, which record the running time of a tractor on a waxed disc, or electrical recorders, which are basically electric clocks switched on and off by the ignition switch of a petrol or vapourizing oil tractor or a pressure switch in the lubrication system of a diesel tractor, are very satisfactory for recording the time spent on an operation. * Fuel consumption may be measured in a variety of ways. the most satisfactory for short tests being to use a detachable tank with a graduated sight-glass connected temporarily with the existing fuel system of the tractor through a two-way valve. With this tank, the tractor can be driven to the site drawing fuel from its own tank and when the timed trial has started the two-way valve can be turned so that fuel is drawn from the calibrated tank.

Apart from the variation between different operations and sites, running costs are influenced from time to time by changes in wage rates and fuel prices. Such changes have taken place since the last revision of costing methods adopted by the Department of Agriculture (2), and the rates which will in future be adopted are given in Tables I and III.

I , Labour Costs.

Since the introduction of the Employees' Provident Fund Ordinance 1951 in July, 1952, it has been compulsory for employees of ten or more men and for estates of more than 25 acres in extent to contribute 5 to 6 per cent of the employees wage to a Provident Fund. Since the majority of tractor owners fall into the class of compulsory contributors it is proposed that until major wage revisions occur all costing figures published in future should be based on the total wages shown in the last column of Table I, which includes the Provident Fund contribution.

Table I.

LABOURERS' DAILY PAY.

	Basic.	* C.O.L.A.	Provident.	Total.
Operator, Special	$5.28	$2.88	$0.38	$8.54
Operator, Class I	4.08	2.20	0.34	6.62
Operator, Class II	3.32	1.80	0.27	5.39
Operator, Class III	2.96	1.56	0.23	4.75
Rotary hoe driver	1.76	0.92	0.15	2.83
Labourer, male	1.52	0.76	0.13	2.41
Labourer, female	1.20	0.64	0.12	1.96

* C.O.L.A. = Cost of Living Allowance.

* It should, however, be noted that the mechanical engine hour meters fitted to certain makes of tractor cannot be used for this purpose as they actually count crankshaft revolutions and not elapsed time.

It will be seen from this table that there are several rates of pay for tractor operators of different classes. In preparing costing figures for publication it is the custom to select a suitable rate of pay in accordance with the difficulty of the work and to use this figure, and not the actual rate paid to the operator who did the work, in the calculations. For example, during the 1953-54 harvesting trials the combine harvester was almost invariably driven by an officer whose pay approximated to $5.87 per hour but in costing calculations it is assumed that a Special Grade Operator earning $0.84 cents per hour would drive.

In the costing method laid down in 1948 (2), hourly charges for labour were calculated on the basis of 6½ hours productive work per day, the total daily pay being divided by 6½ to obtain the hourly figure. Half an hour was allowed for a meal at mid-day and half an hour for maintaining the tractor.

At the present time tractor operators are working an eight hour day including their meal break, and it is proposed that hourly working rates should be based on the daily rate divided by 8 in all costing figures published in future. The time spent on daily maintenance will thus no longer be included in the labour element and due allowance will have to be made in the maintenance element to cover routine maintenance. Hourly labour charges based on the daily pay divided by 8 are given in Table II.

Table II.

HOURLY RATES OF PAY (TO NEAREST CENT).

Operator, Special	$ 1.07
Operator, Class I	0.83
Operator, Class II	0.67
Operator, Class III	0.59
Rotary hoe driver	0.35
Labourer, male	0.35
Operator, female	0.24

II , Fuel Costs.

The cost of the three main fuels used by agricultural tractors varies slightly from time to time and the major oil companies often allow special discounts to large organisations. Prices also very according to the method of packing, bulk deliveries to local storage tanks being cheaper than 44 gallon drums etc., and prices vary with the distance from the main depots. The prices quoted in Table III will be used in all published reports until major price revisions occur.

Estimation of Running Costs.

Where predictions are being made as to the probable cost of an operation which may be carried out in the future, it is necessary to

estimate from experience or from tables of averages, the time which will be taken and the fuel which will be used. The working rates on certain sites of various tractor implement combinations under Malayan conditions are published from time to time, and although tables of average rates for the United Kingdom and United States of America are available, yet in making estimates each site must be considered individually. Fuel consumption is rather less variable and the averages given in Table IV may be used as a guide.

Table III.

FUEL COSTS.

Fuel.	Method of Delivery.	Cost.
Petrol (Motor Spirit)	ex-pump.	$1.50 per gallon
Vapourising oil (Kerosene) in 44 gallon drums	ex-depot.	1.02 per gallon
Diesoline	ex-pump in Kuala Lumpur	0.51 per gallon

Table IV.

FUEL CONSUMPTION OF CERTAIN TRACTORS ON MISCELLANEOUS WORK IN MALAYA.

D = Diesel. P = Petrol. V.O. = Vapourising Oil.

Tractor.	Fuel.	Total Hours.	Total Fuel (Gallons).	Average Consumption (Gallons per Hour).
Caterpillar D4.	D	2,121	2,044	0.964
International TD.6	D	158	152	0.962
D.B. Trackmaster	D	243	220	0.905
Ferguson T.E.A.	P	2,551	2,265	0.888
Ferguson T.E.D.	V.O.	836	463	0.554
Fordson Major (old)	V.O.	3,815	5,181	1.358
Field Marshall	D	919	352	0.383
M.G. 5	P	140	37	0.264
Massey-Harris No. 80 Combine	P	122	212	1.740

The amount of petrol used for starting a diesel or vapourizing oil engine is usually insignificant, especially where long hours are worked

but the averages given in Table V may be used as a guide where accurate costs are required.

Table V.

PETROL CONSUMPTION (FOR STARTING) OF SELECTED DIESEL AND VAPORISING OIL TRACTORS IN MALAYA.

D = Diesel. V.O. = Vapourising Oil.

Tractor.	Type of Fuel.	Number of Tractors Recorded.	Number of Working Hours Recorded.	Average Consumption of Petrol for Starting in Gallons per Working Hour.
Caterpillar D4	D	4	1,661	0.043
Fordson Major (old type)	V.O.	11	3,655	0.096
Ferguson T.E.D.	V.O.	1	836	0.117

B. FIXED COSTS.

III , Maintenance and Repair of Equipment.

The routine maintenance costs of a machine can be determined by a study of log book records over two or more maintenance cycles or predicted from the manufacturer's instruction and service books. The figures given in Table VI for routine maintenance were prepared by the latter method and cross checked with records of tractors used by the Department of Agriculture on Experiment Stations. In every case the predicted figures were higher than the actual costs but it is considered that this is due more to the fact that routine maintenance was neglected in practice than to any serious error in the predictions.

Table VI.

MAINTENANCE CHARGES FOR CERTAIN MACHINES.

Machine.	Maintenance Cycle in Hrs.	Total Cost.	Cost per Hour.
* Ferguson T.E.A. 20	720	$237.33	$0.33
* Fordson Major (new type)	2,000	549.45	0.27
* Massey-Harris No. 80 Combine	1,000	810.60	0.81
† Opperman Baler	50	5.40	0.11
Turner Thresher	10	0.28	0.03
† Robinson Thresher	5	0.21	0.04
‡ Andes Thresher	5	Negligible	Nil
† Tullos Thresher with engine	50	2.90	0.16

* Cost based on Premium Grade Motor Oils at full commercial price.
† No Instruction Books available, based on field experience.
‡ Maintenance consists of a few drops of oil only.

Table VII.

USEFUL LIFE OF MACHINES.

The figures in brackets after the estimated life in years are comparable figures for U.K. given in a Survey by the National Farmers' Union.

Machine.	Estimated Life in Years.	Estimated Hours per Year.	Estimated Life in Hours.
Track-laying Tractors *			
(a) Estate	7.5 (8.0)	1,000	7,500
(b) Contractor	6.0	1,000	6,000
Large-wheeled Tractors †			
(a) Estate	6.0 (7.6)	1,000	6,000
(b) Contractor	5.0	1,000	5,000
Medium-wheeled Tractors †			
(a) Estate	5.0 (7.6)	1,000	5,000
(b) Contractor	4.0	1,000	4,000
Small-wheeled Tractors †			
(a) Estate	5.0 (7.6)	1,000	5,000
(b) Contractor	3.5	1,000	3,500
Horticultural Tractors			
I. Track-laying			
(a) Estate	5.0	750	3,750
(b) Contractor	3.5	750	2,625
II. Others	3.5		
Combines			
I. Self-Propelled	5.0 (7.7)	400	2,000
II. Trailer	5.0	400	2,000
Ploughs	5.0 (11.9)	300	1,500
Disc Harrows	4.0 (9.9)	300	1,200
Mowers	5.0 (14.6)	300	1,500
Threshers	5.0	350	1,650
Balers	7.5 (14.4)	350	2,625
Trailers	10.0	1,000	10,000

* Dozer blades and control units, winches etc. to be considered part of tractor.
† Special wheels or tracks, cabs, hydraulic lift etc. to be considered part of tractor.
‡ Mowers, which have a very seasonal use in U.K., are used all-the-year-round in Malaya.

Table VIII.

DEPRECIATION CHARGES FOR CERTAIN MACHINES.

Machines.	Approximate Cost	Depreciation Hourly
		$ c.
Ferguson TEA-20 on standard wheels	$ 4,350	
(a) Estate		0.87
(b) Contractor		1.08
Ferguson TEA-20 on Bombardier Half-tracks	5,800	
(a) Estate		1.16
(b) Contractor		1.45
Fordson Major Diesel on 14 x 30 pneumatic, with hydraulic etc.	6,945	
(a) Estate		1.39
(b) Contractor		1.73
Massey-Harris 744-D on Half-tracks	11,750	
(a) Estate		2.35
(b) Contractor		2.94
Massey-Harris No. 80 SP. Combine	23,044	11.52
Opperman Baler	2,356	0.90
Turner Thresher	3,500	2.12
Robinson Thresher	2,000 *	1.21
Andes Thresher	421	0.26
Modified Tullos Thresher with engine		
(a) With elevator	1,750	1.06
(b) Without elevator	1,500	0.91
Ferguson disc plough	795	0.53
Burch disc harrow	1,100	0.92
Ferguson Mower	865	0.58
Ferguson Tipping Trailer	1,900	0.20

* This is the 1947 price, a replacement machine would cost more.

In highly mechanized countries, where fields have been worked for many years and repair facilities are good, surveys have shown that the repair element in costs is remarkably low. In the United States of America, for example, a survey of 650 tractors (4) showed that the annual cost of repairs ranged from 1.28 to 3.98 per cent of the original cost of the tractor, depending on age.

In Malaya, however, where field conditions are very bad, operators relatively inexperienced and repair and overhaul facilities less developed, repair costs may be very considerable, especially when the cost of moving the machinery to the workshops in the main towns is taken into consideration. The records of tractors used on Experiment Stations offer little guidance because conditions on such Stations are much better than those normally encountered in Malaya and because the costing system used in the Federal Agricultural Workshops is not a commercial one.

In the absence of comprehensive records of repair costs it is proposed that, with one exception, an approximation of 50 percent of the original cost of the machine should be adopted in future. Where the life of a tractor is five years this will yield an annual repair charge of 10 per cent of the original cost or rather less than three times the maximum figure quoted for American conditions.

An exception will be made to this rule in the case of mouldboard ploughs since experience has shown that the rate of wear on plough shares is very high on certain types of soil. It is proposed, therefore, that the figure of 150 per cent of the original cost of the plough, or about 30 per cent per annum, should be used for calculating the repair costs of mouldboard ploughs used on dry land.

The repair element of costs, being based on a percentage or original cost, is most easily calculated at the same time as the depreciation element; the actual values for various machines are given in Table IX.

IV. Depreciation Costs.

Depreciation is the loss in value of a machine due to legitimate wear, misuse and accidental damage, corrosion and weathering, and to obsolescence. It is obvious that these factors are extremely variable and that there can be no absolute figure for depreciation. Many formulae have been proposed for the calculation of depreciation, some being claimed to give a figure suitable for particular purposes, such as the calculation of second-hand value, others being designed to give an average figure for the costing of operations while yet others are adopted solely to fit in with other book-keeping schemes used by the owner or for income tax purposes.

The straight-line system, in which the value of the machine is reduced by an equal amount each year, yields results which, even if they do not represent the actual value of the machine, are generally understood. The calculations are easy and only one approximation—the service or useful life of the machine—need be made since second-hand market fluctuations and changes in interest rates are not considered.

Table IX.

FIXED COSTS PER HOUR FOR CERTAIN MACHINES AND LABOUR AND FUEL COSTS.

Machine.	Maintenance $	Repair $	Depreciation $	Fixed Cost. $
Ferguson TEA-20 pneumatic tyres :				
(a) Estate	0.33	0.13	0.87	1.63
(b) Contractor	0.33	0.54	1.08	1.95
Ferguson TEA-20 Bombardier Half-tracks :				
(a) Estate	0.33	0.58	1.16	2.07
(b) Contractor	0.33	0.72	1.45	2.50
Fordson Major Diesel on pneumatic tyres :				
(a) Estate	0.27	0.68	1.39	2.34
(b) Contractor	0.27	0.86	1.73	2.86
Massey-Harris No. 80 Combine	0.81	5.76	11.52	18.09
Opperman Baler	0.11	0.45	0.90	1.46*
Turner Thresher	0.03	1.06	2.12	3.21
Robinson Thresher	0.04	3.00†	1.21	1.25
Andes Thresher	—	0.12	0.25	0.37
Modified Tullos :				
(a) With elevator	0.06	0.53	0.06	1.65
(b) Without elevator	0.06	0.45	0.91	1.42
Ferguson disc plough	—	0.26	0.53	0.79
Burch disc harrow	—	0.46	0.92	1.38
Ferguson Mower	—	0.29	0.58	0.87

Labour:	Operator, special	$1.07 per hour.
	,, , class I	0.83 ,, ,,
	,, , class II	0.67 ,, ,,
	,, , class III	0.59 ,, ,,
	Rotary Hoe Driver	0.35 ,, ,,
Labour:	Labourer, female	0.30 ,, ,,
		0.24 ,, ,,

Fuel:	Petrol	$1.50 per gall. ex-pump in Kuala Lumpur.
	Kerosene	$1.02 per gall. in 45 gl. drums ex-depot.
	Diesoline	$0.51 per gall. ex-pump.

* Cost of twine must be included under running cost.
† Field experience has shown that repair costs for this machine are exceptionally high.

Some of the factors influencing depreciation are more a factor of time than use, e.g. such factors as corrosion, weathering and obsolescence will often continue to depreciate the value of a machine whether it is used or not. For this reason machines with a purely seasonal usefulness, such as combines and threshers, have a useful life of comparatively few working hours although they may be in use for many years. Other factors in depreciation, such as legitimate wear, misuse and accidental damage, are greatly influenced by the type of work undertaken. Thus it is considered that some equipment, notably wheeled tractors, will have an appreciably longer life when used on estates and Experiment Stations where the land has been cultivated mechanically for several seasons, than when used for contract work where supervision is less strict and virgin land is commonly cultivated.

An attempt has been made to prepare a revised list of useful lives for various types of machine and it is proposed that this list, which is given in Table VII, should be used for all costings in future.

In Table VIII the hourly charges for depreciation for certain machines calculated on this basis are given. It should be noted that depreciation has been carried on to zero in every case, that is to say, no allowance has been made for the scrap value of the machine after its agriculturally useful life has ended. No allowance has been made for scrap value because of lack of information but it is probable that quite considerable errors may arise through the omission of this factor. For example, a self-propelled combine has been ascribed a useful life of only 2,000 hours but, at the end of this period, the engine will still have a useful life of many thousand hours and should be worth a considerable sum. It will also be noted that no adjustment has been made for different makes of machines. This is because it is considered that there is, as yet, too little evidence on this point to provide specific answers and it would be unfair to manufacturers and agents to make premature estimates.

Total Costs.

The information given in Tables II, III, VI and VIII and the repair charges calculated on the basis described, for certain tractors and machines are given in Table IX. This Table, which will be revised as and when necessary, may be used as a reference when calculating costs by the systems adopted by the Department of Agriculture.

Summary.

1. The various elements which make up the total cost of an operation are enumerated and the relative importance of the four major elements discussed.

2. Methods of measuring running costs are described and current wage rates and fuel costs are given.

3. Methods of predicting running cost are briefly described and tables of average fuel consumption in Malaya given.

4. The method of calculating maintenance costs is described and a table of actual charges for certain machines given.

5. The method of calculating depreciation costs is described and a table of actual charges for certain machines given.

6. A ready-reference table, containing labour and fuel costs and maintenance, repair and depreciation charges for certain machines is given.

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THE USE OF SELF-PROPELLED COMBINE HARVESTERS FOR THE HARVESTING OF WET PADI IN THE NORTH KEDAH PLAIN

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Introduction.

The Combine harvester has, for many years, been considered the most likely machine for solving the problem of harvesting on large-scale mechanized rice farms and for reducing the violent seasonal fluctuations in the labour requirement of the padi crop in certain areas, notably the North Kedah Plain. A trailer-type Mc Cormick-Deering No. 52-R rice combine was purchased by the Department of Agriculture in 1948 and was tested on peat soil in that year (1) and in 1949 (2) and on coastal alluvium soils in Province Wellesley in 1950 (4).

In 1949, E. W. Russell and J. C. Hawkins, in the report on their visit to Malaya (8) stated that combine harvesters fitted with drain lifters and pick-up reels would seem to be the best machines for the harvesting of padi. They recommended, however, that:—

> "On settled land with small fields, the narrowest type of self-propelled machine appears to be most suitable. With trailer machines either a high percentage of the crops will have to be cut by hand round the outside to make room for the combine to start, or if the machine is taken round the field without cutting round, the small amount of grain lost by this method is likely to form too high a percentage of the total crop on the small area for the method to be economic".

As a result of their recommendations, a survey of available combines was made and it was concluded that a Massey-Harris Rice Special Self-Propelled Combine on tracks was the most suitable machine, although it was thought probable that it would be rather large for Malayan conditions. Funds for the purchase of a Massey-Harris No. 27 combine were sought in 1951 but they were not forthcoming until 1953, by which time an improved model, the No. 80, was in production.

This paper is concerned with the testing of the Massey-Harris No. 80 S.P. Rice Special Combine in Kedah during the 1953-54 harvest season and with a discussion of the physical and economic problems which were revealed by the tests.

Field Tests of the No. 80 S.P. Combine in Kedah 1953-54.

The North Kedah Plain was chosen as the site for the 1953-54 field testing programme for several reasons, viz:—

(a) The monsoonal climate of Kedah is more predictable than that of the southern parts of Malaya and favourable weather and soil conditions could confidently be expected.

(b) The uniform planting date and the sudden onset of the dry weather in Kedah leads to an acute shortage of labour at harvest time, (3), and it is possible that combines may, in the future, be introduced to reduce, to some extent, the influx of harvesting gangs from Kelantan and Thailand.

(c) Communications in Kedah are good and the district around Alor Star, the capital town, is one of the few places in Malaya where a large acreage of padi is grown within easy reach of good engineering facilities.

(d) The Experiment Station of the Department of Agriculture at Telok Chengai, a few miles from Alor Star, is large and it had been possible to plant an area 540 yards long by 80 yards wide with a single variety specifically for trials with the the Combine.

During the trials, a total of 63 acres was cut with the No. 80 S.P. Combine, accurate records being maintained for about 35 acres. The total amount of grain handled was about 66¼ tons or 26,480 gantangs. During the preliminary trials at Telok Chengai work was done on 13 days out of a possible 21 days and a total of 16 acres was cut in 40 working hours. In the full field trials work was done on 12 days out of a possible 21 and a total of 47 acres was combined in 82 working hours.

During the preliminary trials attention was paid to the correct setting of the various adjustments, to the grain losses which occurred and to methods of opening out fields and turning corners. The soil was hard and dry, with much surface cracking, at the start of these trials on 17th December, 1953 but 1.15 inches of rain fell between 23rd and 26th December and it was therefore possible to try the Combine under a fairly wide range of soil conditions.

An attempt was made, during the preliminary trials, to teach drivers, who had practised handling the Combine in fields at Serdang, the finer points of combining. Only one man, however, proved capable of handling the machine properly and the Agricultural Development Officer or the Agricultural Engineer usually drove the Combine during the full field trials. It seems probable that it will be difficult to recruit and train men with sufficient intelligence, mechanical knowledge and integrity unless a high basic pay and incentive bonuses can be offered to combine drivers during the harvesting season.

The Combine crew consisted of a driver and a labourer but, whenever possible, a third person was carried to note times and to keep records. These records consisted of a daily diary of general observations on breakdowns etc: and detailed record sheets on which times, yields etc: were noted in tabular form.

General Observations on the Suitability of the No. 80 S.P, Combine for Conditions in Kedah.

In general, the Massey-Harris No. 80 S.P. Rice Combine was more suitable for the conditions met during the 1953-54 season then had been expected but weather, soil and crop conditions greatly influenced both the general performance and the relative efficiency of the three major units, i.e. the traction, the cutting and the thrashing mechanisms.

The Influence of Weather Conditions.

Both minor changes in weather conditions, such as dew and diurnal changes in temperature, and major factors such as wind and rain, affected the Combine. It was found that grain could not satisfactorily be combined when the moisture content was greater than 20 per cent and preliminary observations during the early stages of the tests showed that the moisture content of ripe, standing grain exceeded this value at night and in the early morning even when the weather was fine. It was also found that a very light shower of rain made the grain and straw too damp to harvest for several hours, depending on conditions after the shower, but that torrential rain was necessary before the soil became too soft to bear the Combine.

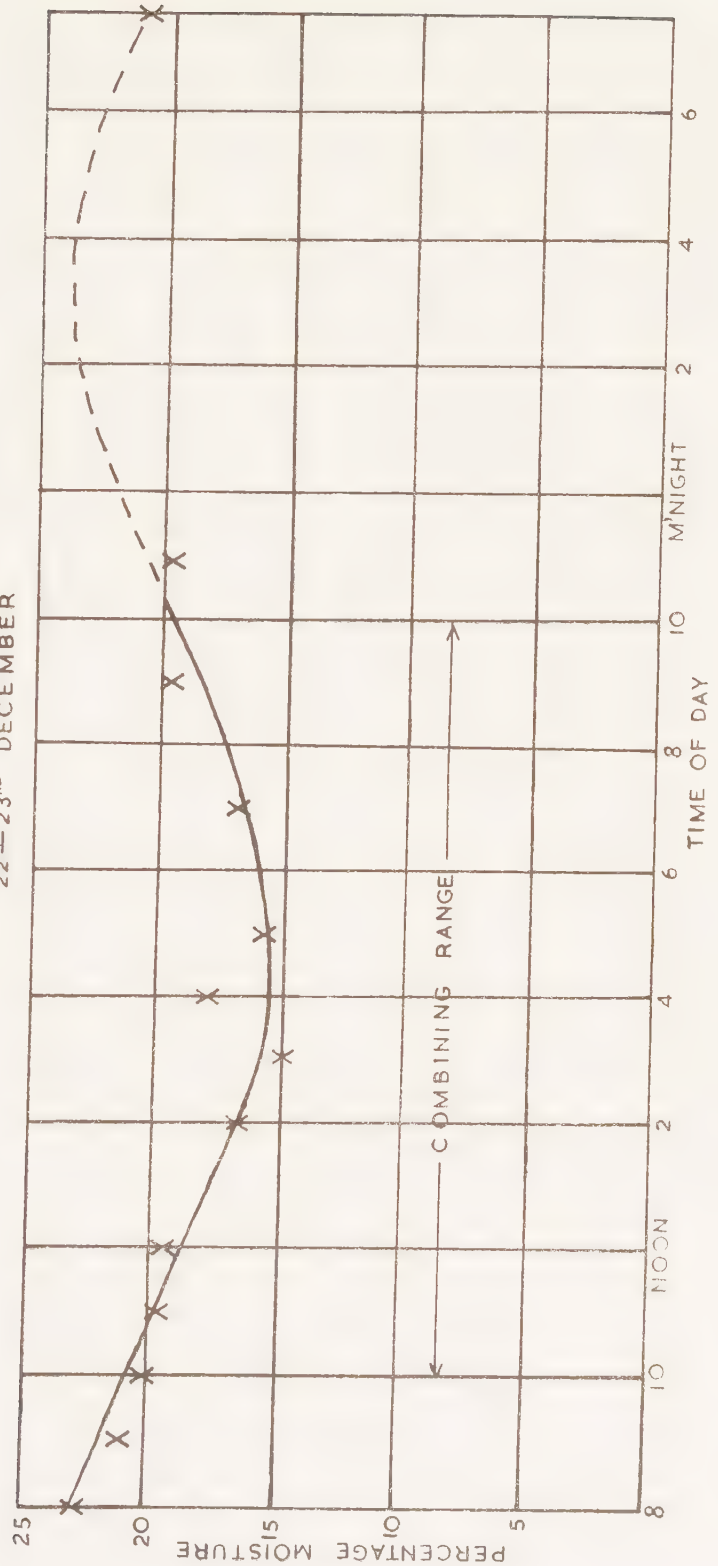
A preliminary sudy of the diurnal variations of the moisture content of ripe, standing padi was made with the "Speedy Moisture Tester" at Telok Chengai on 22-23rd December, 1953. Detailed studies extending over a long period were not made because meterological equipment was not available and it was considered that detailed moisture content figures were valueless unless they were correlated with proper temperature, humidity, wind and rainfall data. The general trend of the figures obtained was, however, considered fairly typical and the deduction made from the graph, which is reproduced as Figure I, that combining would only be possible between about 10 a.m. and 8 p.m. was confirmed by subsequent experience of both day and night work during the full fields trials.

The influence of rain on combining may be summarized as follows:—

Trace	Just sufficient to wet all metal parts of combine.	Grain too damp to combine. Work held up depending on wind and for ½ hour or more sun.
Light Shower	All parts of combine thoroughly wet and drops forming on edges.	Grain and straw too wet to combine. Work held up for several hours depending on wind and sun.
0.01 to 0.10 inches	As recorded by rain gauge.	Work prevented for rest of day.

FIGURE I

DIURNAL VARIATION OF MOISTURE CONTENT OF RIPE PADI



0.10 to 0.85 inches -	As recorded by rain gauge.	Work prevented for several days because wet grain and straw.
More than 0.85 inches.	As recorded by rain gauge.	Work prevented because of wet grain and straw and soft soil.

This summary is, of course, very approximate: the weather conditions after the rain and the nature of the storm itself have a modifying influence on the duration of the interruption of work. During the trials, rain fell on 8 out of a possible 42 days and work was prevented or seriously interrupted on a total of 15 days.

Damp crops were difficult to combine because cutting required more power and the knife drive slip-clutch tended to slip, reducing the knife speed and causing blockages, and because the damp straw tended to wind around the shafts of the elevator, beaters and drum. The proportion of tailings, i.e. material which was too large to pass the grain sieves but too heavy to be winnowed away, was also high in damp crops and blocking of the tailings auger, which returns such material to the drum, occurred very frequently. This latter difficulty also arose where there was a heavy, tall growth of green weeds among the padi. Where combining was interrupted by rain, it was found essential thoroughly to clean the threshing machanism immediately: if this precaution was neglected the damp grain and straw choked the sieves and elevators, causing difficulty when the machine was restarted.

The storage and drying of combined grain is likely to present severe problems in the event of combining becoming an accepted practice but neither the staff nor the facilities for investigations were available during the 1953-54 season. The combined grain was delivered to the owners in sacks in the fields and, where the grain had a moisture content of more than 16 per cent, they were advised to sun-dry it at the earliest opportunity.

Some samples of grain were, however, inspected by an experienced miller and his advice may be summarized as follows:—

Sample at 22 per cent moisture:

Should be dried at once but could be stored in sacks for one or possibly two weeks if the sacks were piled in single rows exposed to the wind.

Sample at 15 per cent moisture:

Could be stored in sheds for up to one month but should be dried out further if possible.

Sample at 13 per cent moisture:

Could be stored for three months in sheds.

The drying of padi in the sun is an established technique but great care will have to be taken with grain which is combined rather wet in

order to avoid "sun-cracking" which occurs when damp grain is dried too quickly and causes considerable losses in milling. The rate of drying in the sun may be quite fast, the content of one sample being reduced from 22.2 per cent to 12.3 per cent in five hours on a hot but overcast day.

THE INFLUENCE OF SOIL CONDITIONS.

At the beginning of the trials there had been no rain for twenty-three days and the soil was very hard and the surface cracked. Heavy rain fell on 23rd to 26th December, 1953 and again on 21st and 23rd January, 1954 and it was thus possible to try the Combine under a very wide range of soil conditions.

The Combine performed well under all but the wettest conditions and steering was easy. The tracks were capable of climbing all the *batas* * encountered in the field and the broad-based, gently sloping *batas* which had been specially built at Telok Chengai, although they resulted in smoother travelling and, presumably, less strain on the chassis, were not found to be essential. The tracks did little or no damage to the *batas* in most cases. The rear wheels left ruts in moist soil conditions but these were not severe enough to interfere with subsequent cultivations.

In wet soil conditions the rear wheels ceased to revolve and dug ruts as much as fourteen inches deep. Under these conditions steering became very difficult, the rear wheels merely acting as rudders and it was apparent that, in Malaya wet conditions may often be encountered during the harvest seasons, consideration must be given to decreasing the bearing pressure at the rear wheels without affecting the steering. Apart from their influence on the steering, the deep ruts left by the rear wheels were sufficiently large to interfere seriously with subsequent cultivations, especially where, as on smallholdings in Kedah, buffalo-drawn wooden ploughs are used.

The tracks made shallow ruts in moist soil but these did not become serious even under the wettest conditions unless forward motion stopped and the Combine was almost bogged. Under normal conditions the tracks were self-cleaning even where the soil was very sticky but if the swathe of straw left on a previous round was crossed whilst turning, an accumulation of mud and straw, which was very difficult to clear away, soon built up around the tracks.

Even when the tracks lost their grip in wet conditions, it was usually possible to reverse the Combine out of a soft spot because the rear wheels, which account for a large proportion of the total draught, could be pushed back along their own ruts. Bogging occurred on many occasions but, except in one case when a tractor-mounted winch was needed to pull the machine from the edge of a fish pond, the Combine was always able to extricate itself and to cut around the soft spot.

The majority of padi fields in Kedah were found to have one or more low-lying and soft areas, often artificially made fish ponds. It was usually possible to cut the larger part of these areas if great care was taken but the time wasted was not commensurate with the grain harvested

* *Batas* — raised ridges or bunds around wet padi.

and since in many cases the crop growing in such areas was less ripe than the remainder of the field, it was thought better to leave small patches to be harvested by hand at a later date.

The Influence of Crop Conditions.

The influence of damp crops upon the threshing mechanism of the Combine has already been described: the varietal characteristics, such as easy shattering, and the yield, which is influenced also by soil fertility, also affect the efficiency of the Combine but the greatest single factor affecting the combining is the complex interaction of varietal character, soil fertility and weather conditions which determine whether the plants are erect or lodged at harvest time. A comparison of the working time in two roughly comparable crops, one of which was standing well and yielding 3,365 lb. per acre and the other badly lodged and yielding 3,165 lb. per acre, showed a difference of 209 per cent in the acreage per machine hour in cost per acre in favour of the crop which was standing well. The ratio between the best crop encountered and the most badly laid crop was even greater, about 355 per cent, but the difference in soil conditions was considerable in this case.

When working in lodged crops the pick-up reel was absolutely essential and, since lodging existed to some degree in practically every field visited, such reels should be recommended as standard equipment for all combines and reapers for Malayan conditions. The general performance of the reel and the range of speed and pitch adjustments provided on the No. 80 S.P. Combine were adequate for all conditions encountered. Under Malayan conditions, however, one end of a small field may be badly lodged and the other standing well and constant adjustment to the height of the reel is required. This is quite impossible on the Massey-Harris No. 80 S.P. Rice Special Combine since the reel arms are positioned vertically by spring-loaded pins in a quadrant of holes and it is necessary to stop the Combine, declutch the threshing mechanism, dismount and enlist the services of one or more bystanders before the reel height can be changed. The provision of a hydraulic control (which could be operated from the hydraulic pump and existing control valves since the table and reel need never be moved simultaneously) would present some difficulty but the ability to deal quickly with changing crop conditions would more than compensate for the cost of the modification.

The dividers fitted to the ends of the cutting table were not completely satisfactory even where the crop was standing well and, under certain conditions, were quite useless. At the present time virtually all the padi in Malaya is transplanted and the crop grows in regularly spaced clumps or "hills": if the Combine was driven so that the divider travelled down the rows of "hills", the standard dividers were completely satisfactory but if the driver's attention wandered and the divider was forced through the "hills" the uncut part of the plant was pushed down and was usually cut off by the exposed end of the knife and fell to the ground. In lodged crops the standard dividers were moderately satisfactory where

the plants had fallen roughly parallel to the path of the combine but, where the direction of cut was dictated by the shape of the field and the plants had fallen across the line of travel, the dividers were quite useless, the crop being pushed down by the extension to the divider and collected under the divider itself. The plants were uprooted and dragged along and the blockage became progressively worse until the table auger suddenly caught the straw and a large bundle was torn loose and fed into the elevator, usually causing a blockage in the threshing mechanism.

This trouble was not confined to the Combine: none of the dividers of various shapes which were tried on various cutting machines during the 1953-54 season were successful and it is obvious that much research must be conducted before the ideal divider for transplanted rice is found. Such research will probably be conducted with small cutting machines since it will be easier to provide interchangeable dividers on specially built frames than on a mass-produced combine. It is, however, noted that the manufacturers offer a long grain divider as optional extras for the Massey-Harris No. 80 S.P. Rice Special Combine and it is probable that the latter type would successfully deal with crops which are lodged at right angles to the direction of cut.

Where crops were lodged it was necessary to cut very low in order to avoid cutting drooping heads with the knife and thus increasing grain losses at the cutter bar. Low cutting was also necessary where the crop was "necked", i.e. the straw had bent at a weak point and the heads were hanging downwards, due to inherent weak straw or to pest damage. Because of the increased volume of straw taken into the machine it was necessary to travel slowly where the crop was lodged or necked, and although improvements to the dividers and provision of hydraulic controls to the reel will increase the overall output, it seems probable that the bulk of material to be handled * will always limit the travelling speed to about 0.6 m.p.h. and the output will never be greater than 0.65 acres per hour under bad conditions.

During the 1953-54 harvesting trials only four named varieties were combined and it is impossible to make any comment on the suitability or otherwise of any variety except to say that the types loosely termed Radin China encountered in the full field trials appeared to be quite satisfactory from the engineers point of view. One desirable characteristic, i.e. a short stiff straw to reduce the tendency to lodge and the bulk of material to be handled, has already been implied and a second characteristic, resistance to shattering, will be noted in a later section when grain losses are considered.

Mechanical Failures and Blockages.

The Massey-Harris No. 80 S.P. Rice Special Combine was

* Three weighings made with a windrower indicate that, in a slightly lodged crop it is necessary to cut at 9 inches above the ground and the amount of material to be handled is about 6 tons per acre. In the case of the Combine, cuts may have to be made much lower than this and, since it is the heaviest-yielding varieties which are most prone to lodging, the amount of material to be handled may well be in the order of 10 tons per acre.

remarkably free from mechanical troubles: routine adjustments, such as correcting belt tensions, occasionally interrupted work for a few minutes and some time was lost through inexpert use, but time lost through all mechanical failures, blockages of the threshing mechanism and accumulations of straw and mud on the tracks averaged less than 10 per cent, see Table I.

Table I.

Trials of Massey-Harris No. 80 S.P. Rice Special Combine 1953-1954. Working Time Lost Through all Causes Except Rain.

Site.	Acreage.	Time Taken in minutes.	Time Lost in minutes.	Percentage time lost.	Remarks.
SH/TC 1	0.4	68	—	Nil	
SH/TC 2	0.7	87	8	9.2	Knife clutch slip.
A 1 -	0.7	65	—	Nil	
A 2 -	0.7	73	30	41.1	Accumulation of mud on tracks.
B 1 -	1.4	242	47	19.4	Blocked drum and tailing auger: adjusting belts.
B 2-4 -	4.3	477	18	3.8	Front beater blockage.
C -	4.3	246	—	Nil	
D 1 -	5.7	773	141	18.2	Rear beater and tailings auger blockages in wet crop.
D 2 -	2.1	245	—	Nil	
D 3 -	0.4	60	10	16.7	Reel arm pivot bolt broken.
D 4 -	2.8	165	—	Nil	
E -	2.8	268	—	Nil	
F -	2.8	137	30	21.9	Tailing auger blockage.
H -	2.5	165	—	Nil	
I -	2.1	172	12	7.0	Straw under chassis.
J -	1.1	165	15	9.1	Rear beater blockage.

Average 9.2%

A general view of the Massey-Harris No. 80 Combine being demonstrated to H.H. the Sultan of Kedah and the Hon. Member for Agriculture and Fisheries.

The Combine working in a lodged crop.

The Combine tracks in muddy conditions.

PLATE II.

The divider working in a lodged crop.

Close-up of a divider showing a broken extension.

Settings.

The approximate settings for the threshing mechanism were found in stationary trials on 14th December, 1953. Minor variations were made during field tests on 18th December and on 21st December a wide range of settings were tried under field conditions in the presence of the manufacturer's representative. It was found that the settings shown in Table II were generally satisfactory and only minor changes were necessary to suit variations in crop conditions. Average grain samples contained less than 1 per cent broken grain, less than 3 per cent husked grain and a small quantity of broken straw.

Table II.

Trials of Massey-Harris No. 80 S.P. Rice Special Combine 1953-54.
List of Settings adopted for Normal Conditions.

Unit.	Setting or Size of Pulley or Sprocket.	Clearance of Speed.
Front Beater	—	920 r.p.m.
Drum	29 tooth sprocket	700 r.p.m.
Concave	Front 5/8 in open Rear 1/8 inch open	5/8 inch. 1/8 inch.
Chaffer	Wide open	—
Chaffer extension	Half open	—
Clean Grain pan	Middle position	—
Cleaning sieve	Half to wide open depending on crop	—
Fan	3/4 open	—
Reel	Normal conditions, 6 5/16 inch pulley Bad conditions, 8 3/8 pulley	25 r.p.m. 19 r.p.m.
Auger	27 tooth sprocket	139 r.p.m.

Grain Losses.

Loss determinations were made at Telok Chengai on a plot of *Mayang Ebos 80* with the object of roughly measuring the losses due to shattering and spillage at the table and the total losses and to indicate the extent the extent to which these losses increased as the grain became overripe. The crop was considered ready for cutting on the afternoon of 26th December but rain made work impossible until 30th December,

so the crop may be considered to have been four days overripe at the start of the determinations. The method of determining losses was not accurate. To determine the shattering and spillage losses, the combine was stopped and the mechanism brought to rest as quickly as possible. A yard square frame was then thrown down under the machine and every grain inside the frame collected: this procedure was repeated on opposite sides of the field. To determine the total losses, the swathe of straw left by the combine was carefully teased out and all loose grains and unthreshed heads allowed to fall on the ground, care being taken to ensure that the grains were all shaken out and that they fell directly to the ground and were not scattered. The yard square frame was then placed on the ground so that one-third was over the ground where the straw had been lying and the remainder to one side, this ratio being chosen because the grain lost by inefficient threshing was concentrated in a strip approximately one-third the width of the cutter bar. After all the grains within the frame had been collected, the procedure was repeated on the opposite side of the field.

After collection, the samples were dried and gently rubbed to remove adherent soil, the loose soil and empty grains being removed by gentle winnowing. samples were then weighed and the results converted to pounds per acre. The results are shown in Table III: it is thought that the high total loss on 30th December, 1953, was due to the fact that the Combine had not been used for several days and that some part of the threshing mechanism was slightly blocked with damp or germinated grain.

Visual estimations in the field at a later date suggested that losses in crops of *Radin China* were less than those recorded at Telok Chengai with the variety *Mayang Ebos 80*. This may have been due to varietal differences or to improved technique as the operators gained experience. It is thought that total losses can be kept down to 3.5 per cent of the total yield and this figure compares with the losses determined in tests of the Massey-Harris No. 726 Self-Propelled Combine conducted by the National Institute of Agricultural Engineering in the United Kingdom where cutter bar losses of 72.5 lbs. per acre and total losses of 116.0 lbs. per acre were recorded in average crops (5) and with the figure of 2.6 per cent of total yield quoted for American conditions (7).

The Opening—Out of Fields.

Towards the end of the harvest season when many of the fields have been cut by hand, fields of padi are often bounded on two or three sides by areas which have already been cut and opening-out presents no problem as the Combine can be turned and manoeuvred on the stubble. At the beginning of the harvest, however, conditions are very different and it may be possible to approach a field only from one angle. The preliminary trials presented an opportunity to study the various methods of opening-out and it was found that the standard method adopted gave very good results in the majority of cases.

Table III.

Trials of Massey-Harris No. 80 S.P. Rice Special Combine 1953-54.
Cutting Table and Total Losses
Variety—Mayang Ebos 80.

No. of days and date.	Condition of Crop.	Cutting Table Losses.		Total Losses.	
		Lb. per acre.	Percentage of yield (approximate)	Lb. per acre.	Percentage of yield (approximate)
4 days, 30.12.53	Straw 52 inches high, cut at 14 inches. Crop slightly laid. Straw dry. Grain moisture content 20 per cent.	69.34	1.7	288.04	7.2
5 days	As above but crop laid rather more by strong wind overnight. Grain moisture content 18 per cent.	176.02	4.4	197.36	4.9
7 days, 2.1.54	Crop badly laid by wind. Grain moisture content 18 per cent.	165.35	4.1	194.69	4.9
8 days, 3.1.54	As above. Grain moisture content 16 per cent.	352.04	8.8	461.39	11.5

The time taken in the opening-out operation was studied on a rather small field belonging to a smallholder adjacent to the Experiment Station at Telok Chengai. The size of the plot was 36 x 95 yards and the acreage 0.706 acres: the area cut in the opening-out cuts was 0.207 acres or 29.3 per cent of the total and the time taken was 31.6 per cent of the total time taken to cut the field.

The Combine travels an average of at least 660 yards per round: one size which satisfies this minimum requirement is 60 x 300 yd., giving an area of 3.72 acres, and it will be seen later that the highest output recorded during the trials was at Site F, which was a field 20 yards wide and 750 yards long.

Working Rates and Output of the Massey-Harris No. 80 S.P. Combine.

The working rates of the Combine in machine hours and man hours per acre for all timed tests is given in chronological order in Table IV. The output in gantangs and lb. per machine hour is given in Table V, the sites again being arranged chronologically. Tables IV and V have been combined in Table VI with the sites arranged according to soil and crop conditions to show how these factors affect outputs.

It will be seen from these tables that the average working rate for all of the tests was 1.80 machine hours per acre, which is equivalent to 0.556 acres per hour, but that there was considerable variation, the highest working rate, 0.80 hours per acre or 1.25 acres per hour, being obtained on a long narrow plot in excellent condition and the lowest, 2.84 hours per acre or 0.35 acres per hour, on a square plot where the crop was badly laid.

The average working rates in different conditions, as shown in Table VI, were:—

Good Conditions	1.04 hours per acre or 0.97 acres per hour.
Average Conditions	1.93 hours per acre or 0.52 acres per hour.
Bad Conditions	2.52 hours per acre or 0.40 acres per hour.

The average output of grain in all the tests was 1,597 lb. or 285.1 gantangs per hour. There was no obvious relationship between yield per acre and output per hour but crop conditions, by their affect on working rates, considerably influenced the output. The average outputs in different conditions, as shown in Table VI, were:—

Good conditions	2,182 lb. or 389.6 gantangs per hour.
Average conditions	1,443 lb. or 257.7 gantangs per hour.
Bad conditions	1,134 lb. or 202.5 gantangs per hour.

The average working rates do not bear any comparison with the figure of "upwards of 50 acres a day" claimed by the manufacturers in one of their advertisements nor do they compare well with the average of 1.93 acres per hour quoted for the harvesting of rice with combines in the United States (7). In the United Kingdom it is usually considered that a combine can harvest 20 to 30 acres per season per foot of cutting with and the results shown in Table VI are very approximately equivalent to 19 acres per full working season per foot of cutting width,

Table IV.

Trials of Massey-Harris No. 80 S.P. Rice Combine 1953-54.

Working Rate in Hours per Acre.

Site		Crop.		Soil.	Working Rate.		
Reference.	Area in acres.	Variety or type of padi.	Yield lb. acre.	Condition.	Condition.	Machine hours per acre.	Man hours	Remarks.
SH/TC 1	0.4	*Subang Intan*	3,921	Lodged badly at edges slightly in middle.	Very hard.	2.81	5.62	First timed test.
SH/TC 2	0.7	*Subang Intan*	3,921	- do -	- do -	2.05	4.10	Second timed test.
A 1	0.7	*Radin China*	1,740	Standing well, rather overripe.	Moist but firm.	1.52	3.04	
A 2	0.7	*Radin China*	2,447	- do -	Moist and soft.	1.71	3.42	Serious delay.
B 1	1.4	*Subang Intan*	3,165	Lodged badly, completely flat.	Moist but firm.	2.84	5.68	Roughly square.
B 2-4	4.3	*Subang Intan*	3,058	B2 flat, B3 and B4 badly lodged.	B2 wet and soft B3-4 firm.	1.86	3.72	Roughly square.
C	4.3	*Radin China*	2,396	Excellent.	Moist but firm	0.95	1.90	
D 1	5.7	*Melor Susun*	2,319	Lodged badly at edges, slightly in middle.	- do -	2.26	4.52	Many blockages.
D 2	2.1	*Melor Susun*	2,379	- do -	- do -	1.60	3.20	
D 3	0.4	*Melor Susun*	2,676	Lodged badly.	- do -	2.82	5.64	
D 4	2.8	*Radin* Type	1,886	Standing well.	Hard.	0.97	1.94	
E	2.8	*Radin China*	3,365	Standing well.	do -	1.36	2.72	
F	2.8	*Radin* Type	1,886	Excellent.	- do -	0.80	1.60	Long narrow field.
H	2.5	*Radin China*	1,445	Standing well.	Moist and soft.	1.10	2.20	
I	2.1	*Radin* Type	1,495	Standing well but necked.	Wet and very soft	1.55	3.10	
J	1.1	*Radin* Type	1,223	Standing well.	Moist and soft.	2.56	5.12	

Table V.

Trials of Massey-Harris No. 80 S.P. Rice Combine 1953-54.

Output in lb. per hour.

Site.		Crop.				Output.	
Reference.	Area	Variety or type of padi.	Yield lb. acre.	Condition.	Condition.	Lb. per machine hour.	gantangs / machine hour.
SH/TC 1	0.4	*Subang Intan*	3,921	Lodged badly at edges, slightly in middle.	Very hard.	1,400	250.0
SH/TC 2	0.7	*Subang Intan*	3,921	- do -	- do -	1,909	340.9
A 1	0.7	*Radin China*	1,740	Standing well, rather overripe.	Moist but firm.	1,740	310.7
A 2	0.7	*Radin China*	2,447	- do -	Moist and soft.	1,430	255.3
B 1	1.4	*Subang Intan*	3,165	Lodged badly, completely flat.	Moist but firm.	1,115	199.0
B 2-4	4.3	*Subang Intan*	3,058	B2 flat, B3 and B4 badly lodged.	B2 wet and soft B3-4 firm.	1,642	293.1
C	4.3	*Radin China*	2,396	Excellent.	Moist but firm.	2,493	445.2
D 1	5.7	*Melor Susun*	2,319	Lodged badly at edges slightly in middle.	- do -	1,024	182.9
D 2	2.1	*Melor Susun*	2,379	- do -	- do -	1,485	265.3
D 3	0.4	*Melor Susun*	2,676	Lodged badly.	- do -	1,305	233.0
D 4	2.8	*Radin* Type	1,886	Standing well.	Hard	1,951	348.4
E	2.8	*Radin China*	3,365	Standing well.	- do -	2,009	358.8
F	2.8	*Radin* Type	1,886	Excellent.	- do -	2,350	419.6
H	2.5	*Radin China*	1,445	Standing well.	Moist and soft.	2,111	376.9
I	2.1	*Radin* Type	1,495	Standing well but necked.	Wet and very soft.	1,113	198.7
J	1.1	*Radin* Type	1,223	Standing well.	Moist and soft.	475	84.7

Table VI.

Trials of Massey-Harris No. 80 S.P. Combine 1953-1954.

Working Rates in hours per acre and outputs in lb. per hour.

Conditions for	Site Reference.	Crop. Crop and Soil Conditions.	Machine Hours per acre.	Lb. per Machine Hours
Good	F	Excellent crop, soil hard.	0.80	2,350
	C	Excellent crop, soil firm.	0.95	2,493
	D 4	Crop standing well, soil hard.	0.97	1,951
	E	Crop standing well, soil hard.	1.36	2,009
	H	Crop standing well, soil soft.	1.10	2,111
		Average in good condition.	1.04	2,183
Average	A 1	Crop standing, overripe soil firm.	1.52	1,740
	A 2	Crop standing, overripe soil firm.	1.71	1,430
	I	Crop standing but necked, soil soft.	1.55	1,113
	D 2	Crop lodged at edges, soil firm.	1.60	1,485
	D 1	Crop lodged at edges, soil firm.	2.26	1,024
	SH/TC 2	Crop lodged slightly, soil hard.	2.05	1,909
	SH/TC 1	Crop lodged slightly, soil hard.	2.81	1,400
		Average for average conditions.	1.93	1,443
Bad	J	Crop standing well, poor yield soil soft.	2.56	475
	B 2-4	Crop badly lodged, soil firm.	1.86	1,642
	D 3	Crop badly lodged, soil firm.	2.82	1,305
	B 1	Crop very badly lodged, soil firm.	2.84	1,115
		Average for bad conditions.	2.52	1,134
		Overall average.	1.80	1,597

The Cost of Harvesting Padi with the Massey-Harris No. 80 S.P. Rice Special Combine.

Estimate of Useful Life.

A preliminary study of the cost of operation showed that the fixed cost element was likely to account for approximately 75 per cent of the total cost of combining. The importance of making a fair estimate of useful life was therefore clear. In estimating the life of the machine in terms of years it was borne in mind that the Massey-Harris No. 80 S.P. Rice Combine is likely to become obsolescent fairly soon and that accidental damage and weathering are likely to be higher in Malaya than in other countries. The average life of 8.3 years for combines of all types quoted for the United States (7) and of 7.7 years for the United Kingdom (6) were considered to be too long for Malayan conditions and it was decided that a life of five years should be assumed.

During the 1953-54 trials the Combine worked for only about 120 hours but much potentially productive time was lost through experimentation during the preliminary trials and full shirt working was not started until January 1954. It was therefore decided that the number of working hours per season should be estimated from other available data.

When the trials commenced on 14th December, 1953 it was noted that some areas of padi which were accessible and suitable for combining had already been harvested and there was no difficulty in obtaining crops until the end of the trials on 27th January, 1954. A working season of 48 days, i.e. 14th December to 31st January, was therefore assumed and the daily rainfall records at Telok Chengai for the past five years were considered in the light of experience gained during the 1953-54 season in order to estimate the number of days on which work would have been possible. These figures are given in Table VII together with the estimated number of working hours, based on shift working at 10 hours per day.

Table VII.

Estimates of Potential Working Times.

Season.	Estimated No. of Working Days.	Estimated No. of Working Hours.
1949 - 50	24	240
1950 - 51	39	390
1951 - 52	38	380
1952 - 53	34	340
1953 - 54	35	350
Total	170	1,700

On the basis of these figures it was decided that a working life of 2,000 hours could be fairly assumed, giving a depreciation cost of $11.52 per hour.

Repair and Maintenance Costs.

The repair costs were assumed to equal 50 per cent of the original cost of the machine over its useful life, giving a figure of $5.76 per hour. Maintenance costs were calculated on the basis of two hours work per day plus the cost of materials and services as laid down in the manufacturers' instruction book and worked out at an average, over a 1,000 hour maintenance cycle, of 81 cents per hour.

Total Fixed Cost.

The total fixed cost, obtained by adding together depreciation, repair and maintenance costs, amounted to $18.09 per hour.

Fuel Costs.

Fuel consumption during the 1953-54 trials averaged 1.71 gallons per working hour, giving an hourly cost of $2.61.

Labour Costs.

In view of the high standard of intelligence and integrity required of combine drivers it is probable that special rates and incentive bonuses will have to be paid in the harvest season. Until the rates of pay are fixed, however, labour charges may be calculated on the following daily rates :

Driver	—	Special Grade	
		$ 5.28	Basic
		2.88	Cost of Living Allowance
		0.38	Employer's contribution to Provident Fund.
Total		$ 8.54	
Bagger	—	Labourer	
		$ 1.52	Basic
		0.76	Cost of Living Allowance
		0.13	Employer's contribution to Provident Fund.
Total		$ 2.41	

These rates give a labour charge, based on an eight hour day, of $1.37 per working hour.

OPERATING COSTS.

The total operating costs during the timed trials during the 1953-54 season are given in Table VIII: the sites are grouped according to conditions as in Table VI and it will be seen that the average costs under different conditions are:—

Good conditions	$ 23.12	per acre
	$ 57.12	per 1,000 gantangs
Average conditions	$ 42.57	per acre
	$ 89.35	per 1,000 gantangs
Bad conditions	$ 55.71	per acre
	$135.37	per 1,000 gantangs
Overall average cost	$ 39.76	per acre
	$ 90.78	per 1,000 gantangs.

The Economics of Combine Harvesting.

The overall average cost of combining during 1953-54, as shown in Table VIII was slightly more than 9 cents per gantang. To this figure must be added a small amount for further winnowing and cleaning and for transport of the padi from the field to the mill and the total cost at the mill will be beween 10 and 12 cents per gantang. The minimum guaranteed price for padi is at present $17 per pickul or about 68 cents per gantang and the total cost of harvesting is thus about 15 to 18 per cent of the value of the crop.

A very large proportion of the padi crop in the North Kedah Plain is harvested on a contract basis by gangs of labourers from Kelantan and Thailand. Unlike other areas, such as the Krian District, where casual labour is drawn from nearby estates and towns, payment is almost invariably made in cash in Kedah because the labourers would find difficulty in carrying home their earnings if payment were made in kind. During the 1953-54 season the influx of labour was much greater than usual and contract prices were therefore lower than in previous years: a record was made of the fluctuation of average contract rates and it was found that these varied from $40 per relong (0.711 acres) in mid-December to $28 per relong at the end of January, the average price being about $30. The contract conditions were very variable and in some cases the smallholder supplied food to the labourers, in which case the cash price was some $10 lower.

The following average contract rates, which include cutting and threshing, but not winnowing or transport, may be compared directly with the costs given in Table VIII for combine harvesting.

Contract Rate of $30 per relong = $42.19 per acre
= approximately 50 cents per man hour
= approximately $93.75 per 1,000 gantangs.

It will be seen that under good conditions combine harvesting is appreciably cheaper than hand labour and that even under average conditions there is a small margin in favour of the Combine. It must be

Table VIII.

Trials of Massey-Harris No. 80 S.P. Combine 1953-54.

Operating Costs.

Conditions for Combining	Crop. Reference.	Crop and Soil Conditions.	Cost per acre.	gantangs. Cost per 1,000
Good	F	Excellent crop, soil firm.	$ 17.72	$ 52.60
	C	Excellent crop, soil firm.	20.97	49.57
	D 4	Crop standing well, soil firm.	22.73	63.35
	E	Crop standing well, soil hard.	29.90	61.51
	H	Crop standing well, soil soft.	24.28	58.56
		Average in good conditions.	$ 23.12	$ 57.12
Average	A 1	Crop standing, overripe, soil firm.	$ 33.55	$ 71.03
	A 2	Crop standing, overripe, soil firm.	37.74	86.45
	I	Crop standing but necked, soil soft.	33.99	111.07
	D 2	Crop lodged at edges, soil firm.	35.38	83.19
	D 1	Crop lodged at edges, soil firm.	49.88	120.66
	SH/TC 2	Crop lodged slightly, soil hard.	45.24	64.74
	SH/TC 1	Crop lodged slightly, soil hard.	62.01	88.28
		Average in average conditions.	$ 42.57	$ 89.35
Bad	J	Crop standing well, poor yield, soil soft.	56.87	260.57
	B 2-4	Crop badly lodged, soil firm.	41.05	75.30
	D 3	Crop badly lodged, soil firm.	62.24	94.72
		Crop very badly lodged, soil firm.	62.68	110.90
		Average for bad conditions.	$ 55.71	$135.37
		Overall average	$ 39.76	$ 90.78

borne in mind, however, that the costs in Table VIII contain only depreciation, repair, maintenance, fuel and labour elements; the cost of the organization necessary for contract work on a large scale, for moving the machine and for housing, insurance and supervision, which are not included, may be very considerable, whereas they are non-existent in the case of labour gangs.

From the figures given in Table VII and the average working rates and outputs given in Tables IV and V it is possible to estimate the total yearly acreage and output which may be expected. In Table IX estimates of the potential output of a Massey-Harris No. 80 S.P. Rice Combine are given for the past five seasons: it will be seen that the totals, although quite impressive in themselves, are quite insignificant when they are compared with the total acreage of padi in Kedah as published from time to time in the Statistical Section of the *Malayan Agricultural Journal*. About 1,450 ten-foot width combines would have been needed to harvest the padi crop in Kedah in 1952-3 and the cost of these machines would be in a region of $33,413,800!

Table IX.

Potential Acreages and Outputs.

Season.	Estimated No. of Working hours.	Estimated Acreage.	Estimated Output in Gantangs.
1949-50	240	133	59,850
1950-51	390	216	97,200
1951-52	380	211	94,950
1952-53	340	189	85,050
1953-54	350	194	87,300
	Total	943	424,350
	Average	189	84,870

Fuller details of the haysweep, the Opperman Baler and another power-take-off driven machine, the Nicholson PB 1 Baling Press, will be given in a later paper.

Summary.

1. The reasons for the purchase of a Self-Propelled Combine are recapitulated and the Massey-Harris No. 80 Self Propelled Rice Special Combine is described.

2. The field trials in Kedah during the 1953-54 season are described and the influence of soil, weather and crop conditions discussed.

3. Time lost through mechanical breakdowns and blockages is shown to have averaged about 10 per cent.
4. The settings used and the methods of opening-out fields are given and the method of determining cutter-bar and total losses described.
5. Working rates and outputs under different conditions are given and it is shown that, under average conditions, the Combine can harvest 0.5 acres per hour although rates of nearly 1.0 acres per hour were achieved on occasions. (Tables IV-VI).
6. An estimate of useful life of the Combine is made for costing purposes and it is shown that, on the basis of a 2,000 hour life, costs varied between $55.71 per acre in bad conditions to $23.12 in good conditions, averaging $39.76. (Table VIII).
7. These costs are compared with contract rates for hand labour and it is shown that, under average conditions there is little difference in the cost of the two methods.
8. An estimate of the number of acres which may be combined by one machine is given. (Table IX)..

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NOTES ON CURRENT INVESTIGATIONS (RESEARCH) JANUARY TO MARCH, 1954.

Padi.

Variety Trials.

With the exception of one in Selangor, all variety trials were reaped during the quarter and results of some trials in Kedah and Pahang have been received and are being analysed. Above average yields are expected from most trials and only two are reported as having failed at Pasir Mas (Kelantan) and Temerloh (Pahang) owing to severe drought following transplanting. Nurseries for 1954-55 trials have been sown at stations in south and east Pahang.

Variety Selection.

All plots of varieties under selection, except Acheh Puteh (Selangor) have been reaped, and initial selections have been made from foundation stocks of the varieties Machang at Titi Serong and Serendah Puteh at the three stations at Negri Sembilan.

Area Trials.

Results of area trials of Serendah Sungei Dua (Kedah), Seri Raja (Central and South Perak), Radin China 17 (Pahang) and Serendah Kuning selection (Negri Sembilan) are being collected. From latest reports the Negri Sembilan trial promises to be particularly successful but Serendah Sungei Dua has had a poor reception by the growers.

Hybridisation.

Field selection has been completed in all ear rows and plots of local and *indica/japonica* hybrids. Further seed of the latter has been received from Cuttack as follows:—

Norin	6 x M.E.80	Gimbozu x Ser.Kn.5003
,,	6 x Sm.29	and backcross to the *indica* parent.
,,	18 x Ser.Kn.5003	Gimbozu x N.5057.
,,	20 x Ser.Kn.5003	Riku 132 x N.5057.
,,	20 x N.5057	(Taichu 65 x M.E.80) x M.E.80.
,,	20 x Sm.29	

Laboratory Investigations.

Imbibition (water absorption) tests have been made on rice of 363 varieties from the medium term variety collection at Pulau Gadong. Variation between varieties is extreme, increase in volume ranging from 50 to 350 per cent.

Nutrient Requirements.

The study of nutrient requirements on Siam 29 in unmanured plots at Tanjong Karang Padi Test Station has continued.

Penyakit Merah.

The study of *penyakit merah* of padi is being pursued from various points of view. Chemical analysis of 11 samples of diseased padi plants from different padi growing areas, made by the Chemistry Division, revealed greater amounts of iron and smaller amounts of potassium in diseased as compared with healthy plants. An experiment is now in progress to test the effect of major element deficiencies and the presence of soluble aluminium on the growth of padi plants. Also a number of soil samples from diseased areas have been collected to study methods of their improvement.

Disease Control.

After the discovery of black smut, (*Neovossia horrida* (Tak.) Padwick and Azmatullah Khan), on the Cuttack hybrids at Telok Chengai Padi Experiment Station, a survey of padi-growing areas of Kedah, Province Wellesley, Malacca, Negri Sembilan and Kelantan revealed the presence of the smut in each of these States/Settlements in very small amounts. This proved that the smut was not introduced on Cuttack hybrid seed as at first suspected. The examination of padi fields in the search for black smut also revealed abundant infections of rice in some fields in Kedah and Kelantan with the false smut, *Ustilaginoidea virens* (Cke.) Tak., indicating that, under certain conditions, false smut may be an important padi disease.

Isolation and study of the various leaf-spotting organisms obtained from padi plants has been continued during the last quatrer.

Pest Control.

Two visits were paid to Krian, to investigate the occurrence of padi stem-borers. At the beginning of January, several padi stations and private holdings were visited and counts showed that borers were attacking 10 to 20 per cent. of tillers in all areas. Poor growth did not seem to be correlated with percentage attack, though borers were more often reported in poor areas because attempts are made there to discover the reason for unhealthy growth.

At harvest time, the beginning of March, this conclusion was supported by further observations. Even in the best stands, borers were often responsible for a 25 per cent. loss of ears, yet an attack of this intensity appears to pass unnoticed by the growers unless growth is poor.

A pot experiment to investigate the effect of EPN 300 and Dieldrin on padi stem-borers was harvested on 3rd March.

Results indicate that borer attack originating during the last month of growth has little effect on the yield. *Sesamia inferens* Walk. did not appear to be reduced by any treatment, though other species were.

Cacao.

Selection and Breeding.

Serdang-Cheras Clones and Progenies.

Experimentation in progress at the Federal Experiment Station, Serdang, involving Serdang-Cheras clones and progenies was discussed and modifications agreed.

Recent Introductions.

Since January, around 500 cuttings of West African Trinitario and Keravat material were rooted from 1,000 sets.

The second consignment of I.C.S. cuttings from Kew was planted at the Federal Experiment Station, Serdang, and is doing well. Only four clones, I.C S. 39, 39, 40, and 45 have survived. The previous importation of similar material from Kew is being multiplied by budding and giving 90 per cent. success.

Upper Amazon seedlings planted at the Federal Experiment Station, Serdang, in October, 1952, were flowering freely, a number of pods having set and the fruit should ripen in April. Compatibility testing is in progress.

The *Herrania* sp. in the Fruit Nursery is flowering freely.

Pod Analysis.

Analysis of 3,900 ripe pods from the various experimental fields was made and entered in the clip-card record.

Fermentation.

Studies have started on methods for small-scale fermentation of cacao. The development of a suitable method is imperative for the success of future selection and breeding work.

Pest Control.

In order to check damage to trunks and branches by the borers (*Zeuzera* spp.), 100 Amelonado trees were sprayed with 1.8 per cent. Dieldrin (active ingredient); counts of bore holes were made before spraying and will be continued at 2 week intervals for one year, spraying to be done every 3 months. There are 100 control trees. After two inspections, the Dieldrin-treated trees show fewer bore-holes.

In order to study the night movement of *Apogonia* spp. a test was carried out in January, releasing painted beetles on marked trees. 10 per cent. were recovered on the following night and there were further reductions on subsequent nights.

A similar test was carried out in March on dry nights. Only 4 to 5 per cent. of releases were recovered in a week's search.

A more detailed test is projected in which it is hoped to follow the dispersion of the beetles.

Oil Palm.

Breeding Programme.

Work during the quarter has been concentrated on production of dumpy/tenera material. Ten dumpy inflorescences have been pollinated, all with West African pisifera.

Nine dumpy bunches, all pollinated with West African pisifera have been reaped, yielding some 4,210 seeds. Half of these have been sown in sand beds, the remainder have been despatched to I.R.H.O. as agreed. Pedigree tenera x tenera and dura x pisifera seeds have been received from I.R.H.O. in return.

"Bronzing", Leaf Analyses.

The leaf samples from healthy "yellow" and "orange-spotted" palms at fronds 3, 5, 9, 13, 17, 21 and 25 of five families have been completed. This work, entailing about 2,000 estimations, has been one of the major items completed during the quarter.

The last sampling (done December, 1953) of the series involving fronds 3 and 17, ex Field 4, Federal Experiment Station, Serdang, are nearing completion of analysis. It is considered that a reappraisal be made before any further leaf anlyses are carried out.

Analyses of leaf samples of immature palms ex an estate in the coastal area of Selangor have also been completed.

Pest Control.

A visit was paid to an oil palm estate in South Perak on 15th February, following a report of serious damage by *Setora nitens* Walk. Investigations showed, however, that *Orthocraspeda trima* Moore was primarily responsible. *Setora* was present but not numerous, and was very heavily parasitised. In view of this fact, and since *Orthocraspeda* was not parasitised, it was advised that lead arsenate dust should be used as a control measure.

Another South Perak estate was visited on 11th March to investigate an outbreak of bagworms over 1,000 acres. Serious damage was observed and there was no sign of recovery by the palms. Since parasitised *Setora nitens* was found to be present, lead arsenate was again advised.

Coconut.

Breeding.

Observations on coconut flowering and investigations into the viability of pollen under different storage conditions are being carried out.

Tea.

Rooting Trials.

Trials of various media to improve rooting of cuttings are nearing completion at Cameron Highlands.

Quality Tests.

Four prepared leaf samples from Experiment F.E.S.S.4 (application of copper) have been forwarded to the Colonial Products Advisory Bureau for quality appraisal.

Disease Control.

Experiments have been completed with several different fungicides and dusting *versus* spraying in the control of blister blight of tea at Cameron Highlands Experiment Station but the results have not yet been analysed. It seems, however, that dusting with copper fungicide gave satisfactory results.

Pineapple.

Selection.

Routine inspections of selection plots at Jalan Kebun have been made and recording continued. Most clones have either fruited or are flowering and slips from the former have been collected for despatch to Alor Bukit for the establishment of selection plots there.

Pest Control.

The experiment on the inoculation of potted Sarawak pineapples with mealy-bugs has continued. Two of the inoculated plants have wilted and the others are looking yellower than the control. All plants have fruited but inoculated plants produced fruits on an average 74 days later than the controls and their fruits are much smaller and appear dried.

Spraying tests, using Aldrex 2 and Dieldrex 15 at dilutions ranging from 1 : 20 to 1 : 500, acted as a repellent to mealy-bugs but other treatments were ineffective.

Disease Control and Soil Mineral Deficiencies.

Careful examination of pineapple plantations in Johore and Perak indicates that, outside of various soil deficiencies weakening the plants and predisposing them to certain diseases, this crop is relatively free from pathogenic diseases of economic importance. A bacterial heart rot was found in trace amounts on two estates but inoculation tests in the laboratory indicate that wounding of the plant is necessary before the infection can become established. Even when heart rot infection becomes established, the plants growing in rich soil recover quite readily.

A deficiency disease of pineapples growing on peat soil, the so-called "green wilt", is effectively controlled by the application of copper sulphate. There are indications, however, that deficiencies other than copper occur on peat soils and preliminary tests were suggested to the management of two estates to determine the necessary elements and their proper proportions.

Pasture and Fodder.

Green Fodder.

Final analyses were carried out on samples from Experiments F.E.S.S. 25 and 127, which have now been discontinued.

Monthly samplings are continuing of grass from Experiment F.E.S.S. 126. So far treatment in the region of N|P|K: 2/1/1 is showing the highest yield per unit area of protein in green fodder.

The first 48 samples of *Stylosanthes gracilis* from Kelantan (KN/97—Manurial trial) were analysed for total moisture and crude protein content. Two lb. samples of each plot were sun-dried on site to stabilise the material for the journey to the laboratory. Knowing the original sample weight, it is possible to compute total moisture after oven drying and protein losses in transit were minimised.

Vegetables and Food Crops.

Five plots of bulked selections at the Federal Experiment Station, Kuala Lumpur have been harvested and the results are being examined.

Groundnut.

Records of vegetative characters have been made on the selection lines growing at Federal Experiment Station, Serdang. Growth has been unsatisfactory and the experiment will need to be repeated.

Sweet Potato.

The variety collection is being maintained at Federal Experiment Station, Serdang but no further botanical studies have been carried out.

Banana.

The variety collection at Federal Experiment Station, Serdang has been maintained and records have been made of fruit which has matured. The collection has been recently replanted in a more favourable site.

Disease Control.

Vegetables. A test to determine whether fumigation of soil with DD would reduce the incidence of soft rot in vegetables was made at Serdang and Cameron Highlands Experiment Stations on the crop of "pak choy" (Chinese cabbage). No difference in the prevalence of disease was observed.

Banana. Eight varieties of bananas, namely, *embun, awak betul, nangka, berangan bunga, abu betul, kelat, awak legor* and *raja,* were tested for their susceptibility to Panama disease at Federal Experiment Station, Serdang. With the exception of *embun,* all the varieties that were tested appear to be resistant to the disease.

Cloves.

A large number of clove borer pupae was brought from Penang and most have emerged successfully. Of ten pairs of *Niraeus* the majority has mated, but only four of 13 pairs of *Aphrodisium* have done so. Eggs of both species have been obtained after caging females on wild Eugenia plants. Insecticidal tests against eggs and adults are in progress.

Plant Insecticides.

Derris. The first series of derris selection samples has been completed. Analyses for moisture, rotenone and total ether extract have been made.

Soils Investigations.

Soil Survey, Singapore.

The soil survey of 16,000 acres of potential food crop land in Singapore has been completed. The soils are derived mainly from Triassic sediments of variable composition and the complexity of the resultant soil pattern emphasises the importance of the geology as the chief soil-forming factor.

Sixty-three soil profile-pits have been examined and sampled during course of the survey. Field work was completed on the 30th March, and it is hoped to complete the analysis and present the final report fairly soon.

Soil Survey, Trans-Perak River.

Large numbers of soil samples have been taken by the Consultant Engineers engaged on the survey parties at the same time as levels were being done. To date five rentices at mile intervals have been sampled. The results so far show mineral soils up to a distance of five to six miles west of the bank of the Perak River and then deep peat for another three miles or so before sand is encountered near the coast. Two visits to the area have been made by officers of the Soils Division in connection with the soil survey.

"Gelam" Soils.

A general reconnaissance has been made of the north Kedah and south Perlis irrigation areas. These adjacent areas, till quite recently "gelam" swamps, were found to have been almost completely opened up for padi growing. Very few of the well-drained areas remain uncultivated; limited areas which had been assiduously avoided by pioneering padi planters proved, on examination, to be 'deep' and permanently waterlogged. Only in such areas, is there any smell of H_2S, indicative of sulphurous soil conditions.

Soil samples were taken from a proposed new padi test station on the Arau Canal in Perlis and also from:—

(i) a high-yielding area opened up for 20 years;
(ii) an area opened up for 3 years;
(iii) two undisturbed "gelam" areas, one well-drained and the other water-logged.

These samples are in process of analysis. Available results show very low pH values and low total sulphur contents in the top 3 ft. of soil. The low content of sulphur is probably due to effective leaching following extensive and deep drying and cracking-out of these soils during the prolonged dry season. The outstanding feature of these Kedah soils is the extent to which they dry out during the dry season.

Instructions on Soil Sampling.

While in Kedah, opportunity was taken to give elementary instructional talks to the Agricultural Assistants on methods of soil sampling and identification of local soil series.

Laboratory Investigations.

Determinations of the cation exchange capacities of representative soil samples from different parts of the country by the copper acetate method have been continued. Of 221 samples selected, the C.E.C. has so far been determined on 120.

Laboratory Technique Investigations.

Plant Analyses.

Work has proceeded on improved methods of chemical analyses, mainly centreing around colour development and photoelectric colorimetry, in analyses of crop leaf samples.

The "versenate" method for calcium and magnesium determinations has now passed the "teething" stage, and is on trial against the methods in use.

Soil Analyses.

New rapid methods for the determination of total sulphur and free sulphur in soils have been tried out. The method for total sulphur was found to work satisfactorily and is being developed for routine use on sulphurous soils.

The Lange Flame Photometer has been put into operation and is being used for the routine determination of "available" and total potassium in soils. Sodium and calcium determinations have also been done successfully, but are not yet on a routine basis. Some difficulty has been found in determining calcium because of interference by phosphate and aluminium. Both ions depress the calcium readings, but can be removed from solution by chemical methods.

Methods of determining soil phosphorus are under investigation. The Rubber Research Institute's method of extraction using a mixture of ammonium fluoride and hydrochloric acid adjusted to pH 1.8 has been put into routine use and interesting results are being obtained.

Extraction of "available" phosphate using 0.5 M sodium bicarbonate adjusted to pH 8.5 is also under investigation, and other extracting solutions such as citric acid, acetic acid and sodium hydroxide will be used in order to find which method or combination of methods gives the best indication of phosphate sufficiency or deficiency—especially in padi soils.

Miscellaneous Pests.

Termites.

An experiment was started to determine the residual effect of Dieldrin in soil when used against termites. Dieldrex 15 at concentrations of 1 : 500, 1 : 750, 1 : 1000 and 1 : 1250 was applied to 1 ft. cube boxes of soil, 2 litres a box giving saturation. After six weeks, all treatments are still equally effective.

Stem-boring Caterpillar (*Terastia meticulosalis* Guen.)

The stem-boring caterpillar (*Terastia meticulosalis* Guen.) of *Erythrina indica* was sent from Kedah where it was boring in the seeds, a part of the tree not previously recorded as being attacked in Malaya.

Caterpillars of Artona zebraica Butl.

Caterpillars believed to be those of *Artona zebraica* Butl. were reported defoliating an area of *Axonopus* sp. at Federal Experiment Station, Serdang. A lead arsenate spray was said to give effective control. So far as is known this is the first time that the larval stage of *A.zebraica*, or of any of the rather similar species of *Artona* not found on palms has been recorded.

NOTES ON CURRENT INVESTIGATIONS (AGRONOMY), JANUARY TO MARCH, 1954.

Padi.

Harvest is complete in most localities, except on the Selangor coast and some experimental results have been received for analysis. Good crops have been reported from many areas and visual responses from fertilizer applications have been noted in most States, notably in Negri Sembilan and parts of Perak.

A good crop is expected from a liming and cultivation experiment at Paya Besar, Pahang, on soil which was at one time thought to be unsuitable for padi.

Several experiments have been damaged by *penyakit merah* in Province Wellesley and serious rat damage has been noted at Sala Kanan, Kedah.

Two fertilizer experiments were wiped out by floods in the nursery stage at Panchang Bedena, Selangor.

At Telok Chengai, Kedah, where yields of up to 914 gantangs per acre have been recorded, it has been noted that tractor-ploughed plots have yielded better than those ploughed by buffaloes.

At Pulau Gadong, Malacca, the combination of liming and mole-draining in 1953 appears to have benefitted growth on *gĕlam* soil. The drainage holes were still intact at harvest time.

Cacao.

Investigations at the Federal Experiment Station, Jerangau, suggest that the chlorotic wilt of young plants of Amelonado cacao can be prevented by the use of either superphosphate at ½ oz. per basket or similar quantities of ground magnesium limestone. The more expensive alternative of using one-third of coarse sand in the compost is less practicable at Jerangau.

More extensive trials carried out at Serdang with imported Jerangau soil gave negative results because wilt symptoms failed to develop in control treatments. However, these trials indicated clearly that the use of sulphate of ammonia in basket mixtures caused severe root damage and retarded development. Heavy doses of sulphate of potash can also have harmful effects but small quantities of balanced mixtures using organic nitrogen were beneficial and well-rotted cattle manure also gave very good results.

An experiment to compare eight different densities of shade and four watering frequencies on seedling cacao was commenced at Serdang in February.

An extension block of Amelonado cacao at the same locality which was planted in October, 1951, is now coming into bearing.

In a seed-at-stake trial using Amelonado cacao, removal of mucilage from beans before sowing appeared to be beneficial since it avoided damage to cotyledons from some soil pest, probably ants. Rodent damage in this trial has been almost non-existent, whereas it has been severe in similar trials in Trengganu.

Cacao and durians are growing very well together at Selama Agricultural Station, Perak and 10 per cent of these cacao trees are now in bearing. This method of cultivation should appeal to small-holders.

Oil Palm.

A co-operative manurial experiment on a Selangor estate received its fifth application of fertilizer during the quarter. The palms are now in bearing but harvest has been delayed by transport difficulties.

Fibres.

Manila hemp.

Fibre extraction using a Hagotan stripper has commenced at Degong Agricultural Station where both Tangongon and Bangulanon have grown well. In spite of excessive vibration at high speeds the Hagotan has performed well and promising fibre samples have been prepared.

Variable growth of this crop on a north Johore estate, situated on Segamat series volcanic soil, was probably due to intensive food-cropping during the Occupation. The better areas of Tangongon are very good indeed.

New Zealand Flax.

A seedling population of *Phormium tenax* flax has grown very rapidly indeed on wet soils at the Federal Experiment Station, Cameron Highlands. The best seedlings may well provide a useful crop for valley bottom highland soils which are too wet for tea.

Tea.

Yields per acre from a nitrogen manurial experiment at the Federal Experiment Station, Cameron Highlands are summarized below for the nine-month period June, 1953, to February, 1954:—

Yield of Green Leaf per Acre.

Sulphate of ammonia, lb. nitrogen per acre per year.

0	40	80	120	
3,503	3,690	3,765	3,956	lb.

It will be noted that, although increments per lb. of nitrogen are relatively low, yields are very high indeed. The whole of this experiment receives an annual basic dressing of 30 lb. per acre each of P_2O_5 as rock phosphate, and K_2O as muriate of potash.

At the same locality a factorial NPK manurial trial is in progress but it is still too soon to analyse yields.

In a pruning trial, on which tipping commenced in February it was noted that the lighter the pruning the more rapid was subsequent recovery.

Pineapple.

The plant crop of Singapore Canning in a factorial cultural and manurial trial at the Federal Experiment Station, Alor Bukit, Johore, showed clearly that yields can be very considerably increased by adopting close spacing. Actual yields and average fruit size are summarized below:—

Treatment	Spacing	Plants per	Yield of fruit in lb. per acre	Fruit size in lb.
S_1	1 x 2 x 4 ft.	14,520	21,760	2.308
S_2	6 x 2 ft.	3,630	9,781	3.208
Standard error	—	—	±504.75	±0.5296

The rather small fruit size was doubtless the result of spraying with hormone at nine months from planting. It is now considered that this was too soon and a period of 13 to 15 months is favoured instead. In the same experiment yields of fruit from plots receiving rock phosphate were superior to those from plots receiving equivalent dressings of super-phosphate but the difference did not attain statistical significance.

The Sarawak plots in this experiment have not yet fruited as they were not affected by the hormone application.

Another spacing trial on a Johore estate has also shown that yields can be increased by close spacing but Johore planters consider that closer spacings than 2 x 2 x 5 ft. are not practicable, nor do harvesting labourers like the three-row arrangement.

An intercultivation and manurial experiment with rubber on bog soils in Selangor gave 30,346 lb. per acre per annum from the fourth and fifth crops.

Observations on minor elements experiments both in Selangor and Johore suggest that nutrient sprays of copper, manganese and iron are all beneficial.

Coffee.

A careful examination of crops of Liberian coffee growing on bog soils on the Selangor coast has revealed that in no case was this crop growing well where the depth of peat exceeded 21 in. However, promising young crops are growing in manurial trials on deep peat at the Federal Experiment Station, Jalan Kebun.

Vegetable and Food Crops.

Variety trials of Pak Choy, (*Brassica chinensis*) and Lobak (Chinese radish) have been in progress in Kuala Lumpur while growers'

trials of the same vegetables have also been organized in many different localities. Early observations suggest that local varieties may be better than imported ones under unfavourable conditions.

In the fourth crop of a long-term vegetable manurial experiment at the Federal Experiment Station, Cameron Highlands, the yield of cabbage from plots manured with a bean cake mixture was three times that from plots manured with a heavier and more expensive dressing of prawn dust. Since all organic manures are placed in the soil it has been possible to reduce fly breeding on the Station. However, Chinese growers elsewhere in the Highlands show no indication of following Departmental example since they continue to encourage flies by top-dressing with wet prawn dust. The fifth crop in this experiment was to have been beet but severe cut-worm damage prevented satisfactory establishment so the resistant crop, lobak, has been grown instead.

It has been established that the very promising Jubilee Hybrid cabbage can be grown from axillary cuttings. These are being distributed for growers' trials.

Miscellaneous Crops.

A number of trade enquiries have been received for supplies of *Rauwolfia* root since the alkaloids of the non-Malayan *R. serpentina* have been introduced into medicine for their hypotensive action. Root of the allied indigenous *R. perakensis* has been supplied to several research workers but it has not yet been established that this species is of equal value. Since this plant is nowhere abundant, a few seedlings have been raised at the Federal Experiment Station, Kuala Lumpur to guard against possible requirements of planting material.

Conophor nut vines at Gajah Mati, Kedah are bearing fruit but most of these have dropped while still green.

Livestock.

Goats.

The Serdang herd has been freed from quarantine and the few remaining positive reactors to Melioidosis are to be destroyed.

Pigs.

Imported Large Black, Large White and Wessex Saddleback boars at Serdang are in good health and will soon be fit for service.

NOTES ON EXTENSION WORK (FIELD), JANUARY TO MARCH, 1954.

Compiled by the Chief Field Officer.

Padi.

The padi harvest is almost completed and except on the east coast, yields have been better than average.

Some reports have been received on the results of the season's extension trials with both manures and improved varieties. In Kedah one selected variety S.S.D. 25 was outyielded by the local variety, but another, S.I.117, was consistently superior. The State Agricultural Officer, Negri Sembilan, reports that both the manurial and the varietal extension trials have succeeded better than he expected; it is now most likely that very few of the 200 plots laid down will be failures. Much has been learnt in this first season's work and since they have roused considerable interest in all districts there should be no difficulty in expanding these trials in the coming season.

Rubber.

Distribution of planting material slowed down during the quarter with the approach of the dry season. 67,000 clonal seedlings and 12,900 yards of budwood were sold. A further 2,700,000 clonal seeds were received for planting in seedling nurseries. The production of improved planting material is the responsibility of the Department. Budwood nurseries are maintained at the State and Settlement Agricultural Stations and formerly the clonal seedling nurseries were also esablished at these stations. Policy is now changing, and most State/Settlement Departments are finding it more advantageous to give this work out to contract. Large central nurseries are established whence the seedlings are pulled and transported by lorry to the smallholders.

The Department has provided field staff to assist in a pilot survey of rubber smallholdings that was organised by the Joint Working Party on the Rubber Industry. Surveys have been conducted on smallholdings up to 25 acres in size and on holdings of 25 to 100 acres.

The fall in the price of rubber has not resulted in substantial areas being left untapped. In some areas owners have themselves resumed the tapping of their holdings and ceased the practice of letting out their holdings to contractors on a share basis. There are also local signs of an increase in the will to form marketing societies as several new societies and organisations have been started in Perak and other older schemes are displaying renewed activity.

Fruit.

During the quarter 10,460 budded fruit trees were sold from the Agricultural Stations. Demand is increasing, particularly for rambutans, as more people become aware of the superior qualities of the Department's selections. A new factor is the provision in the Rubber Replanting Scheme Replanting Scheme for the planting of alternative crops to rubber and numbers of owners have elected to plant fruit trees.

The work and skill involved in the production of budded rambutans are considerably greater than for many other fruits and rapid expansion is a task of considerable difficulty. The long dry season has always been a limiting factor in Kedah, and the recent installation of an overhead irrigation system has led to a very early improvement in production.

Livestock.

Poultry.

211 head of poultry, 1,669 chicks and 3,040 eggs for hatching were sold during the quarter.

The State Agricultural Officer, Selangor, reports that the present financial position has apparently caused a greater demand for day-old chicks rather for than the more expensive two month old birds which have been brought on in batteries and inoculated against the ranikhet disease before being offered for sale.

The Negri Sembilan poultry project, financed by the Rural and Industrial Development Authority and run by the Department, commenced operation in February. The incubator has a maximum capacity of 5,600 eggs.

Pigs.

The extension work with the Middle White breed continues at a satisfactory rate. Stud centres in the new villages are now too numerous for full records to be kept of production and services. During the quarter, 208 pure bred pigs were sold as against 147 for the previous quarter from the Department's farms. Most breeders still favour the first cross, but an increasing number of breeders are now prepared to breed from high grade to pure sows.

Agricultural Education.

A wide range of activities in rural education has been reported from all States and Settlements. Plans for the building of hostels and lecture rooms for residential courses are being considered and their erection awaits the provision of funds. These residential courses, which may last from a few days to a fortnight, are well attended and their further expansion is only limited by the shortage of funds for providing the essential transport and subsistence allowances.

The field staff in all areas have as a matter of routine work lectured to schools, civic courses and parties of farmers. In Selangor the Agricultural Assistant, Ulu Langat, and the Rubber Instructor, Kajang, are members of an Agricultural Forum of the Air in which replies are given to questions submitted by letter. The popularity of this broadcast increases and now many questions have to be answered by letter.

MECHANISATION

Half-Yearly Report, October, 1953 to March, 1954.

Compiled by the Senior Agronomist and Agricultural Engineer I.

Recent Importations.

The following new machinery has been received:—

Burch Reversible Disc Harrow.
Ferguson Tiller.
Lenfield Cultivator Frame with ploughing attachment.
Danarm Junior power saw with attachments.
Andes Thresher.
Rayat Thresher.
Ransome Hand-Powered Groundnut Sheller.

The following machines were loaned by the local agents to the Department of Agriculture for testing:—

B.M.B. President Tractor with hydraulic lift and a wide range of cultivating implements.
Benford Mechanical Wheelbarrow.

Tests and Modifications.

Mechanical Harvesting of Padi.

Tests with the Massey Harris No. 80 S.P. Combine were made in Kedah during December 1953 and January 1964; a report on these tests will be found elsewhere in this issue.

The McConnel Jay Windrower and two locally made headers were tested in Kedah and further trials will be made with the former machine in the Tanjong Karang area during April, 1954. A total of six threshers have been tested at various sites in Kedah (December, 1953), Perak (February and March, 1954) and Province Wellesley (March, 1954) and tests with three of these machines will be made in the Tanjong Karang area in April, 1954. A report will be included in a later issue of this Journal but present indications are that the larger threshers, such as the Robinson and the Turner, are an economic proposition when used on padi cut by hand and that the smaller machines although they are proportionally more expensive to run, and may even cost more than hand threshing, considerably reduce the labour required for padi harvesting.

Padi Transporters.

It is possible, therefore, that in some areas, it may be economical to employ a fairly large thresher which could not be taken into fields and to transport the cut padi to a central point with some form of transporter attached to a tractor. Two different transporters were built at Serdang and were tested in Perak during the harvesting trials.

The "Jib" transporter, illustrated in PLATE I, consists of a long, forked jib mounted on the power lift of a Ferguson tractor, the padi being carried in a large bag slung from the jib. The "Box" transporter, see PLATE II, is a very large transport box designed to carry light, bulky material. The capacity of both these machines was the equivalent of about 100 lb. of threshed grain and either machine, with two men, could keep pace with a thresher, such as the Robinson or the Turner, when the haul was less than 120 yards but transport charges were high. In one test costs worked out at $4.42 per hour, which was equivalent to about $21.10 per thousand gantangs of padi, with a haul of 50 yards.

The "Jib" transporter was easier to load and empty than the "Box" but the loaded bag tended to swing and it was dangerous when crossing *batas* or on public roads. The "Box" was quite safe under all circumstances and can be used all the year round for normal transport work.

Straw Balers.

An Opperman lightweight motorised baler was used to bale the straw left by the Combine and the threshers during the trials in Kedah. Preliminary tests indicated that three men could produce about ½ ton of bales per hour and that the cost of baling was about $5 per ton. This baler is now working in Kelantan; a Nicholson Baling Press, arranged for tractor power-take-off drive, is due to come into operation in Negri Sembilan in April, 1954. A full report on these balers will be included in a later issue of this Journal but present indications are that small balers provide an economical method of handling padi straw so that it can be used for mulching, bedding and, perhaps, cattle feed.

The B.M.B. President Tractor.

As a result of the rather poor performance of the B.M.B. President tractor submitted for test in 1952, the manufacturers have loaned the Department of Agriculture one of their latest type of tractor and tests with this machine are now in progress. The tractor and the range of implements provided were received in good order and ready for work and the only mechanical failure so far recorded has been a bent steering arm crank. The general purpose plough has been satisfactory under nursery conditions but the rate of working is low, averaging about eight hours per acre on small plots.

Drum-Drier for Chinese Tea.

A drum-drier for the manufacture of Chinese tea has been developed by the Agricultural Development Officer, Cameron Highlands, from a standard ½-cubic yard cement-mixer driven by a 5 H.P. diesel engine.

The schedule of factory operations is as follows:—

(1) Green leaf is withered overnight in a 4 to 6 in. deep heap on a cement floor with occasional stirring to promote an even wither.

PLATE I

Jib Transporter.

PLATE II.

Box Transporter.

(2) Next morning the withered leaf is heated for about 15 minutes until flaccid in a *kuali* * type of metal cooking pot.

(3) The leaf is then rolled, by hand or foot, for 1½ to 2 hours, the exact period being dependent on pressure exerted during rolling.

(4) Rolled leaf is then placed in the drum-drier and heated until crisp-dry over a moderate wood fire for about 1½ hours. During this drying period the drum revolves slowly at 15 to 20 r.p.m.

Use of this type of drier avoids uneven drying; saves labour, reduces the percentage of dust in the made tea and gives a better appearance to the finished product. Two such drum-driers are now in operation on small tea estates at Cameron Highlands. Experience with these indicates that Chinese tea prepared by this method sells at a premium of $15 to 20 per pikul over *kuali*-dried tea. One full load of the drum-drier yields about 50 katis of made tea.

This type of drier promises to be of considerable value to smaller tea estates both in the highlands and lowlands.

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* Round-bottomed cooking pot made of metal in the larger sizes.

Departmental Notes

Appointments.

Mr. A. E. Billington, Canning Officer, has been appointed to act as Senior Chemist with effect from the 1st April, 1954.

Mr. Kao Wei Tsan, appointed Assistant Chemist with effect from 2nd March, 1954.

The following appointments have been made under the Colombo Plan:—

Mr. A. P. Edwards, a supernumerary Agronomist with effect from the 8th March, 1954.

Mr. R. J. Lockard, a supernumerary Botanist as Plant Physiologist with effect from 19th April, 1954.

Transfer.

Mr. B. C. Balbernie, Agronomist, has been transferred to the post of Agricultural Officer, Selangor Coast North, with effect from the 1st February, 1954.

Returned from Leave.

The following officers have returned from leave:—

Mr. L. N. H. Larter, Senior Botanist, on the 27th January, 1954.

Mr. R. J. A. W. Lever, Entomologist, on 6th February, 1954.

Mr. P. A. Gething, Senior Agricultural Officer, with effect from 2nd June, 1954.

Mr. J. R. Milburn, Agricultural Officer, with effect from 16th June, 1954.

Mr. H. K. Ashby, Senior Agricultural Officer, with effect from 22nd June, 1954.

The following officers have proceeded on leave:—

Mr. A. Johnston, Plant Pathologist, with effect from the 4th March, 1954.

Mr. E. J. H. Berwick, Senior Agricultural Officer, with effect from the 1st April, 1954.

Mr. A. Cumming, Agricultural Development Officer, with effect from the 6th April, 1954.

Mr. J. J. Holmes, Publications Officer, with effect from 15th April, 1954.

Mr. H. F. Logan, Administrative Officer, with effect from 7th May, 1954.

Dr. W. N. Scott, Senior Agricultural Officer with effect from 30th June, 1954.

Retirement.

Mr. Gunn Lay Teik ,O.B.E., Senior Chemist, who first retired in 1951 and kindly agreed to return from retirement to assist the Depart-

ment during a time of shortage of qualified officers, retired again on the 1st April, 1954.

Honours and Awards.

Che' Ja'afar bin Mampak, O.B.E., Assistant Agricultural Officer, Trengganu, has been created Dato Kamal Wangsa by command of His Highness the Sultan of Trengganu.

Tuan Haji Min bin Haji Ahmad, Junior Agricultural Officer, Penang, was awarded the British Empire Medal in the Queen's Birthday Honours.

Che. Yahaya bin Abu Bakar, Junior Agricultural Assistant, Kedah, has been awarded the Kedah Meritorious Service Decoration by command of His Highness the Sultan of Kedah.

Promotion.

Che. Abdul Hamid bin Haji Hussain promoted to Assistant Agricultural Officer, Perlis, with effect from 6th June, 1954.

Postings.

Mr. P. A. Gething, Senior Agricultural Officer, has been appointed State Agricultural Officer, Selangor, with effect from 3rd June, 1954.

Mr. J. R. Milburn, Agricultural Officer, has been appointed Settlement Agricultural Officer, Penang & Province Wellesley, with effect from 21st June, 1954.

Mr. J. S. Ure, Agricultural Officer, has been appointed Agronomist-in-Charge, Federal Experiment Station, Serdang, with effect from 21st June, 1954.

Mr. H. K. Ashby, Senior Agricultural Officer, has been appointed State Agricultural Officer, Johore, with effect from 30th June, 1954.

Cessation of Publication.

It has been decided to discontinue publication of the *Malayan Agricultural Statistics* in the Economic Series. The issue No. 15 for the year 1949, published in 1951, will therefore be the last.

MARKET PRICES

January to March, 1954.

Rubber.—The Singapore market was closed for the first three days of the year, and on the 4th January the price of No. 1 R.S.S., Spot Loose, Buyer, was 56¾ cents per lb. The price fluctuated during the first half of the month but fell to 53½ cents by the 26th and was 54⅝ on the 30th. The average price for January was 55.36 cents—3.11 cents lower than the average price in December, 1953.

There was little improvement in February; the price reached 55 cents per lb., on the 2nd and 5th of the month but then fell steadily to 53⅜ cents on the 27th—the last day for business in February. The average price was 54.20 cents.

On the 2nd March the price fell to 52⅞ cents per lb., the lowest price for four years. However, there was a gradual improvement later in the month, and on the 31st the price was 56⅛ cents. The average for March was 54.30 cents.

The average prices paid for smallholders' rubber at three centres in the Federation of Malaya during the period January to March, 1954, are given in Table I.

Table I.

Average Monthly Prices Paid by Local Dealers for Smallholders' Rubber, January to March, 1954.

(Dollars per picul of 133 1/3 lbs.)

Grades.	Taiping, Perak.			Seremban, Negri Sembilan.			Batu Pahat, Johore.		
	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.
Smoked Sheet	62.96	61.21	61.38	61.78	60.12	60.52	60.69	59.43	59.70
Unsmoked Sheet	50.16	48.71	50.47	45.78	44.98	45.74	53.16	50.42	52.26
Scrap	29.35	23.96	27.27	29.65	27.67	29.33	18.25	17.30	17.84

This Table has been compiled from statistics supplied by the Registrar of Statistics, Federation of Malaya.

Tea.—There were no public sales of Malayan tea in Colombo during the period January to March, 1954. The average prices paid for Ceylon teas at the sale held in Colombo on the 29th March, 1954, as quoted in

the Weekly Report of the Colombo Brokers' Association, were in rupees per lb.: High Grown Teas 2.68, Medium Grown Teas 2.41, Low Grown Teas 2.28.

In a return published by the Registrar of Statistics, Federation of Malaya, production of made tea in the Federation, as declared by estates, during the first quarter of 1954 was given as 36,545 lbs. green teas and 1,038,040 lbs. black teas.

The retail price of Malayan tea (Boh) in Kuala Lumpur decreased from $2.60 to $2.50 per lb. from February, 1954.

Derris.—In January and February the price of this commodity, as quoted in the weekly reports of the Singapore Chamber of Commerce, remained at $100 per picul, but by the 8th March it had risen to $105 and remained at that price until the end of the month.

Rice.—During April the ration was increased to 5 katis * for males, 4 katis for females and 3½ katis for children of Government imported rice per week. The retail prices of rationed rice are, in cents per kati, High Grade 38 and Lower Grade 21-22, both unchanged, Special Grade and Medium Grade—no maximum price.

Table II.

Singapore Prices of Various Agricultural Products.

(Dollars per picul)

Date	Copra, Sundried	Coconut oil*	Pepper. F.A.Q. Muntok white	Pepper. Gen. Muntok white	Gambier, Cube	Sago Flour, Lingga	Tapioca Flour No. 1	Oilcake, Round
1954								
4th Jan. -	40.00	63.50	330.00	340.00	64.00	14.75	15.75	16.50
11th Jan. -	41.00	66.50	325.00	335.00	64.00	14.75	15.75	16.50
18th Jan. -	41.00	67.50	340.00	350.00	63.00	15.00	15.50	16.50
25th Jan. -	42.25	67.50	340.00	350.00	62.00	15.00	15.50	16.50
1st Feb. -	41.50	67.00	345.00	355.00	62.00	15.00	16.00	16.50
8th Feb. -	40.50	66.50	340.00	350.00	62.00	14.75	16.25	16.50
15th Feb. -	37.25	63.00	345.00	355.00	62.00	14.75	16.00	16.50
22nd Feb. -	38.00	61.50	350.00	360.00	60.00	14.50	16.00	16.50
1st Mar. -	35.00	58.00	347.50	352.50	60.00	14.25	17.00	16.00
8th Mar. -	33.50	56.50	345.00	355.00	59.00	14.25	17.50	16.00
15th Mar. -	33.00	55.00	335.00	345.00	59.00	14.00	18.00	15.00
22nd Mar. -	31.25	55.00	305.00	315.00	57.00	14.00	18.25	15.00
29th Mar. -	31.50	55.00	265.00	275.00	57.00	13.75	17.50	15.00

* F.O.B.

The above prices are taken from the weekly reports of the Singapore Chamber of Commerce.

* 1 kati = 1⅓ lb.

FEDERATION OF MALAYA
PRODUCTION OF PALM OIL AND KERNELS.
(In long tons as declared by Estates)

Month	Palm Oil		Palm Kernels	
	1953	1954	1953	1954
January	3,946	4,143	1,008	1,139
February	3,611	3,908	923	1,066
March	3,778	4,442	1,031	1,210
April	4,061		1,066	
May	4,209		1,076	
June	4,122		1,056	
July	4,500		1,150	
August	3,980		1,000	
September	4,180		1,059	
October	4,083		1,063	
November	4,026		1,064	
December	4,602		1,173	
Total	49,098	(12,493)	12,669	(3,415)

In March, 47 estates (planted area 97,883 acres) were in production out of a total of 63 oil palm estates (planted area 109,127 acres).

MALAYAN AGRICULTURAL EXPORTS, OCTOBER-DECEMBER, 1953.

Product	Net Exports in Tons. Year 1952	Year 1953	Oct.-Dec., 1952	Oct.-Dec., 1953
Arecanuts	10,467	11,580	3,060	4,673
Coconuts, fresh † ‡	94,024 †	88,315 †	37,898 †	23,356 †
Coconut oil ‡	65,113	60,779	22,769	23,350
Copra ‡	27,821 *	9,751 *	6,407 *	8,693
Copra cake	60,287 *	59,129 *	11,159 *	12,801
Gambier, all kinds	94 *	160 *	46 *	84
Palm Kernels	10,869	12,884 §	3,105	2,988 §
Palm Oil	46,008	47,579	12,767	13,055
Pineapples, canned	11,762	17,368	3,161	3,031
Rubber ¶	582,649 ¶	572,792 ¶	155,434 ¶	149,978 ¶
Sago,—flour	19,146	28,444	6,211	5,707
„ —pearl	5,553	5,896	1,472	1,375
„ —raw	24,835 *	27,246 *	7,786 *	7,136
Tapioca,—flake	39 *	128 *	11 *	15
„ —flour	4,075 *	7,362 *	1,081 *	1,621 *
„ —pearl	6,304	5,474	907	1,773
Derris	13 *	10	2	1
‡ Copra equivalent	79,868	90,781	31,350	29,718

¶ production (Federation of Malaya). † hundreds in number. * net imports.

§ oil palm fruits and kernels.

FEDERATION OF MALAYA RUBBER PRODUCTION.

(In long tons, dry weight)

Month	Estates		Smallholdings (Estimated)		Total	
	1953	1954	1953	1954	1953	1954
January	31,354	30,278	23,514	19,014	54,868	49,292
February	23,423	25,354	19,140	17,913	42,563	43,267
March	26,898	24,556	16,882	17,452	43,780	42,008
April	26,155		16,805		42,960	
May	27,820		17,679		45,499	
June	27,202		17,024		44,226	
July	30,188		20,400		50,588	
August	29,511		21,491		51,002	
September	28,934		18,394		47,328	
October	30,064		19,202		49,266	
November	28,985		19,250		48,235	
December	30,583		21,894		52,477	
Total	341,117	(80,188)	231,675	(54,379)	572,792	(134,567)
Total 1952	341,078		241,571		582,649	

This Table has been compiled from statistics published by the Registrar of Statistics, Federation of Malaya.

Production on smallholdings (estates of less than 100 acres) is taken as the total of purchases from smallholders reported by licensed dealers.

FEDERATION OF MALAYA

PRODUCTION OF COPRA, COCONUT OIL AND COPRA CAKE.

(ton)

Month	Copra Production						Coconut Oil Production		Copra Cake (Poonac) Manufactured	
	Estates		Smallholdings (estimated)		Total		Oil Mills		Oil Mills	
	1953	1954	1953	1954	1953	1954	1953	1954	1953	1954
January	2,555	3,057	8,241	9,792	10,796	12,849	5,597	8,837	3,594	5,583
February	2,405	2,730	6,092	9,943	8,497	12,673	4,236	7,798	2,694	4,891
March	2,793	2,975	6,703	12,670	9,496	15,645	4,800	8,690	2,981	5,468
April	2,753		7,972		10,725		5,294		3,379	
May	3,306		8,744		12,050		5,666		3,633	
June	3,357		9,842		13,199		6,478		4,078	
July	4,196		9,718		13,914		6,699		4,308	
August	4,070		11,179		15,249		7,935		5,048	
September	4,103		10,332		14,435		7,789		5,043	
October	3,890		11,998		15,888		8,808		5,607	
November	3,137		11,265		14,402		7,776		4,900	
December	3,565		9,580		13,145		8,381		5,157	
Total	40,130	(8,762)	111,666	(32,405)	151,796	(41,167)	79,459	(25,325)	50,422	(15,942)

Notes:—1. The above Table has been compiled from statistics published by the Registrar of Statistics, Federation of Malaya.

2. Estate copra production and coconut oil production are as declared by estates and oil mills respectively.

3. Statistics of smallholding coconut oil production are not available.

4. Smallholding copra production for commercial purposes is estimated from the formula: imports + estate stocks (opening) + estate production + smallholding production = exports + local oil mill consumption + estate stocks (closing).

METEOROLOGICAL SUMMARY, MALAYA, DECEMBER, 1953.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall			Number of days					Bright Sunshine		
	Means of			Absolute Extremes				At 1 foot	At 4 feet	Total		Most in a day	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorms	Fog morning obs.	Gale force 8 or more	Total	Daily Mean.	Per cent.
	A Max.	B Min.	Means A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	°F	°F	in.	mm.	Amt. in.						hr.	hr.	
Ipoh, Perak	91.1	71.8	81.5	95.2	65.0	83.6	75.0			11.30	287.0	2.10	15	14	3	1		215.00	6.93	
Kuala Lumpur, Selangor	89.8	73.1	81.5	93.0	69.0	79.9	75.0			9.12	231.4	1.48	18	16	9	6				
Sitiawan, Perak	88.3	72.1	80.2	91.4	67.0	80.5	75.2	83.7	85.2	10.27	260.9	3.46	13	13	2	1		198.65	6.41	
Kuantan, Pahang	85.5	70.8	78.1	89.3	67.6	75.0	76.6			26.15	664.2	6.78	21	20		1		166.20	5.36	
Bayan Lepas, Penang	87.8	73.1	80.5	90.3	66.9	82.7	77.0			6.32	160.5	2.55	13	10	4			227.40	7.33	
Malacca	86.7	74.1	80.4	90.4	71.1	78.5	75.8			5.27	133.9	1.77	15	12	5			203.75	6.57	
Mersing, Johore	84.5	73.1	78.8	90.5	69.9	75.0	78.9			10.94	277.9	4.88	20	15	1			166.55	5.37	
Alor Star, Kedah	88.9	71.3	80.1	91.8	66.0	83.6	74.4			3.67	93.2	2.38	12	10				217.90	7.03	
Kota Bharu, Kelantan	84.5	73.3	78.9	87.0	68.8	80.9	76.0	81.7	83.8	29.21	741.9	9.77	18	18	3			192.45	6.21	
K. Trengganu, Trengganu	84.4	72.7	78.5	86.5	69.0	79.0	74.9			14.52	368.8	4.01	20	18		1		192.80	6.22	
Kallang Aerodrome (S'pore)	88.2	74.7	81.5	91.5	71.9	79.9	77.0			6.74	171.2	2.14	13	9	6			152.15	4.91	
HILL STATION.																				
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	72.0	56.1	64.1	77.0	42.0	67.0	63.0			5.31	134.9	0.76	16					143.22	4.62	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, JANUARY, 1954.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes								Number of days								
	A. Max.	B Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total		Most in a day Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak	90.3	72.0	81.1	93.6	66.8	84.2	75.0			5.48	139.2	1.38	14	12				193.95	6.26	
Kuala Lumpur, Selangor	88.9	72.8	80.9	92.9	68.4	82.0	75.0			8.95	227.3	2.38	19	17	5	12				
Sitiawan, Perak	88.0	73.0	80.5	91.2	71.0	80.2	75.3	84.0	84.9	10.24	260.1	2.46	15	14	6	4		199.45	6.43	
Kuantan, Pahang	84.9	70.8	77.9	88.6	65.7	76.2	74.3	79.8		16.23	412.2	4.90	21	20		2		155.75	5.02	
Bayan Lepas, Penang	87.7	73.1	80.4	92.0	68.2	81.4	75.6			4.27	108.5	1.05	13		1		1	220.25	7.10	
Malacca	86.1	73.6	79.9	89.7	71.2	78.6	75.7			7.39	187.7	1.81	19	18			3	180.35	5.82	
Mersing, Johore	82.5	72.5	77.5	85.0	69.6	77.4	76.5			17.59	446.8	5.25	26	20				126.40	4.05	
Alor Star, Kedah	89.7	72.0	80.8	92.0	67.9	85.1	74.8			6.75	171.5	3.21	11	7				228.10	7.36	
Kota Bharu, Kelantan	84.6	73.6	79.1	86.8	70.4	79.8	77.3	81.5	83.0	12.00	304.8	3.47	17	14		2		204.20	6.59	
K. Trengganu, Trengganu	83.5	72.6	78.1	86.0	68.8	79.0	76.2			11.82	300.2	3.01	19	18		6		197.60	6.37	
Kallang Aerodrome (S'pore)	87.1	74.0	80.5	91.4	71.5	80.7	76.9			6.48	162.8	1.30	20	17	1		1	106.45	3.43	
HILL STATION.																				
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	72.1	56.2	64.1	76.0	46.0	69.0	63.0			6.17	156.7	1.62	18	18				131.15	4.23	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, FEBRUARY, 1954.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes									Number of days							
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total		Most in a day Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak	92.8	72.5	82.7	96.0	70.0	85.3	74.8			10.78	272.8	2.18	13	13	4			240.50	8.59	
Kuala Lumpur, Selangor	90.7	72.8	81.7	93.7	68.9	84.0	74.9			7.68	195.1	2.16	16	12	7	8				
Sitiawan, Perak	88.6	72.9	80.7	91.8	69.4	81.6	74.8	84.4	85.2	14.70	373.4	4.10	15	13	7			219.15	7.83	
Kuantan, Pahang	86.7	70.5	78.6	90.0	64.2	83.7	73.1	80.5		5.53	140.5	2.80	12	11	2			195.30	6.97	
Bayan Lepas, Penang	88.9	74.2	81.5	91.8	72.0	81.2	76.0			4.79	121.7	1.85	11	10	2			255.95	9.14	
Malacca	88.5	73.9	81.2	92.1	71.7	83.1	76.0			3.51	89.2	1.89	10	9			3	211.80	7.56	
Mersing, Johore	83.9	73.7	78.8	86.5	69.6	79.6	77.9			5.46	138.7	3.31	12	10				190.85	6.82	
Alor Star, Kedah	92.3	70.6	81.5	94.9	64.3	87.8	74.8			1.29	32.8	0.96	2	2				263.50	9.41	
Kota Bharu, Kelantan	87.0	72.1	79.5	89.4	66.8	84.9	76.6	84.7	85.2	0.78	19.8	0.65	6	2				258.85	9.24	
K. Trengganu, Trengganu	85.6	71.7	78.5	87.7	67.6	83.7	76.7			0.60	15.2	0.20	9	7				248.80	8.89	
Kallang Aerodrome (S'pore)	88.9	74.4	81.7	92.0	71.0	85.1	76.9			8.47	215.1	2.72	13	12	3			158.35	5.65	
HILL STATION.																				
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	72.7	55.5	64.1	76.0	45.0	69.0	62.0			3.36	85.3	0.96	11	11						

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, MARCH, 1954.

LOCALITY	AIR TEMPERATURE DEGREES FAHRENHEIT							EARTH TEMP.		RAINFALL								BRIGHT SUNSHINE		
	Means of												Number of days							
	A. Max	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total		Most in a day Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak	93.0	72.8	82.9	96.2	69.8	89.1	75.5			14.48	367.8	3.80	21	19	7		1	248.35	8.01	
Kuala Lumpur, Selangor	91.0	73.0	82.0	94.0	70.3	78.8	76.4			9.32	236.7	1.96	17	17	12	11				
Sitiawan, Perak	89.5	73.2	81.3	92.4	70.3	83.7	75.6	89.5	73.2	8.60	218.4	1.36	18	13	10	2		223.75	9.22	
Kuantan, Pahang	87.8	71.1	79.5	92.3	66.3	79.8	75.5	82.1		14.22	361.2	3.54	17	15		2		186.80	6.03	
Bayan Lepas, Penang	89.1	74.0	81.5	91.8	71.0	85.0	77.3			2.99	75.9	0.59	16	15	8			241.75	7.80	
Malacca	88.5	73.9	81.2	92.4	71.0	81.4	76.7			2.19	55.6	0.69	10	9				229.30	7.40	
Mersing, Johore	85.6	72.1	78.9	89.6	68.1	80.4	79.2			18.44	468.4	4.64	15	15			2	199.05	6.42	
Alor Star, Kedah	92.7	72.6	82.7	96.1	68.3	89.0	76.8			5.95	151.1	1.77	8	8	5			259.95	8.39	
Kota Bharu, Kelantan	87.9	74.0	80.9	91.2	69.0	84.8	77.8	86.1	86.7	3.43	87.1	0.89	12	11	1	1		260.85	8.41	
K. Trengganu, Trengganu	86.8	73.2	80.5	89.5	69.2	81.0	77.6			5.89	35.3	2.36	15	13				245.45	7.92	
Kallang Aerodrome (S'pore)	87.5	74.8	81.1	92.6	72.8	78.0	78.0			3.70	9.40	1.16	14	9	4			165.75	5.35	
HILL STATION.																				
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	74.3	56.8	65.5	78.0	46.0	72.0	63.0			9.74	247.4	2.46	15	14				161.00	5.37	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, APRIL, 1954.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes									Number of days							
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total		Most in a day Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak	92.5	74.4	83.5	95.8	71.7	89.2	76.0			7.76	197.1	2.10	16	13	2			195.35	6.51	
Kuala Lumpur, Selangor	90.1	74.0	82.1	93.9	71.5	81.1	75.8			12.95	328.9	2.82	22	19	14	16				
Sitiawan, Perak	90.1	74.3	82.2	91.8	72.4	85.2	76.4	85.4	86.1	7.25	184.2	1.80	16	11	9	1		197.45	6.58	
Kuantan, Pahang	89.6	72.4	81.0	93.6	70.2	82.0	75.8	83.6		4.81	122.2	2.04	17	12	1			184.45	6.15	
Bayan Lepas, Penang	89.1	75.2	82.1	91.9	73.8	86.4	77.2			14.27	362.5	3.06	21	18	6			198.75	6.63	
Malacca	86.6	74.6	80.6	91.1	72.0	81.0	76.4			9.04	229.6	2.34	20	16	3			191.30	6.38	
Mersing, Johore	88.4	72.4	80.4	91.0	70.9	85.1	74.9			2.93	74.4	1.27	10	9	1			221.75	7.39	
Alor Star, Kedah	91.6	74.4	83.0	94.9	72.2	86.4	77.0			10.25	260.4	2.92	21	17	6			237.05	7.90	
Kota Bharu, Kelantan	89.9	74.1	82.0	93.8	72.0	85.3	76.8	89.2	88.4	3.44	87.4	1.63	7	5	1			260.60	8.69	
K. Trengganu, Trengganu	88.9	73.7	81.3	91.8	71.9	84.8	75.8			2.38	60.5	0.96	5	4	3			243.15	8.11	
Kallang Aerodrome (S'pore)	88.2	75.6	81.9	91.5	71.3	82.5	78.0			8.79	223.3	1.55	19	14	12			144.20	4.81	
HILL STATION.																				
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	74.5	58.1	66.3	77.0	52.0	72.0	62.0			9.44	239.8	1.70	21	21				132.00	4.40	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, MAY, 1954.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes									Number of days							
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total		Most in a day Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak	91.9	73.9	82.9	96.6	71.2	85.6	77.0			10.36	263.1	1.41	21	18	8			193.50	6.24	
Kuala Lumpur, Selangor	90.4	74.5	82.5	94.9	71.8	82.5	77.0			8.84	224.5	1.84	23	19	11	13				
Sitiawan, Perak	89.4	74.1	81.7	93.0	72.1	82.0	76.9	85.5	86.2	5.16	131.1	2.31	16	11	6	3		195.25	6.30	
Kuantan, Pahang	88.4	72.8	80.6	91.7	69.8	82.1	75.6	83.1		6.20	157.5	1.80	15	11	6	5		181.40	5.85	
Bayan Lepas, Penang	88.2	75.2	81.7	91.8	72.9	84.0	77.7			9.82	249.4	3.20	20	16	3			202.85	6.54	
Malacca	86.0	74.9	80.5	90.7	72.1	78.3	77.1			7.91	200.9	2.39	14	12	3			197.55	6.37	
Mersing, Johore	88.3	72.4	80.3	91.7	69.1	82.1	74.5			9.47	240.5	1.52	19	18	5	1	1	216.25	6.97	
Alor Star, Kedah	89.3	74.7	82.0	94.4	72.7	82.3	75.9			4.64	117.9	1.15	12	10	1			196.40	6.33	
Kota Bharu, Kelantan	88.3	74.9	81.6	91.3	73.2	82.2	76.8	85.7	87.4	6.63	168.4	2.38	15	11	4			212.60	6.86	
K. Trengganu, Trengganu	88.3	73.8	82.1	90.9	71.2	82.2	75.5			7.19	182.6	3.10	15	10	5			242.15	7.81	
Kallang Aerodrome (S'pore)	87.8	76.3	82.1	92.8	73.9	80.3	80.0			2.89	73.4	0.49	12	11	6			182.20	5.88	
HILL STATION.																				
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	74.3	53.0	63.7	78.8	45.0	67.4	62.5			8.84	224.5	1.43	23	21				147.50	4.75	

Compiled from Returns supplied by the Malayan Meteorological Service.